Programme Structure

Bachelor (Honors/ Honors with research) in Environmental Sciences

Programme Code: SBR0703

Batch: 2023-27

Department of Environmental sciences

Sharda School of Basic Sciences & Research

Programme Structure
Department of Environmental Sciences
Sharda School of Basic Sciences & Research, Sharda University

		Subject 1	Subject 2	Subject 3		Subject 4	Vocational	Compulsory Co-curricular	Training/ Survey/ Project/ RBL	Credits	(Total Credits) After completion {Minimum Credits} [Max Duration in years]
		Major (Environmental Science)	Major (Environmental Science)	Major (Environmental Science)		Minor/ Elective	Minor	Minor	Major		
		Credits 4/5	Credits 4	Credits 3/4/5	project	Credits ¾	Credits 3	Credits 2	Credits 2/3/9		
Year	Sem.	Own Faculty	Own Faculty	Own/other Faculty		Other Subject/ Faculty	Vocational/skill development	Co-Curricular Course	Related to main Subject		
1	I	Fundamentals of Environmental Science (4) + Fundamentals of Environmental Science Lab (1)		Ecology and Ecosystems (3) + LAB (1)		Descriptive Statistics (3)	Environmental data presentation: Step forward from laboratory to industry I	Communicative English -1 (2)	Environmental Management (3)/Any VAC (3)	20	**(40)** CERTIFICATE IN BASIC ENVIRONMENTAL SCIENCE
	II	Water Resources (4) + Water Resources Lab (1)	Biodiversity and Conservation (3) + LAB (1)			Mathematical Expectations and Probability Distribution (3)	Environmental data presentation: Step forward from laboratory to industry II	Communicative English - 2 (2)	Yoga for Holistic health (3)/Any VAC(3)	20	
2	III	Atmosphere and global climate change (4) + LAB (1)	Analytical Techniques (3) + Analytical Lab I (1)		RBL-1(Audit)	Data Preparation and Data Cleaning (3) + Environmental Microbiology (3) + LAB (1)	Environmental data presentation: Step forward from laboratory to industry III	Logical Skill Building & Soft Skills (2)		21	**(80)** DIPLOMA IN ENVIRONMENTAL SCIENCE
	IV	Green Technologies (4) + Analytical Lab II (1)	Air Pollution and Technologies (3) + LAB (1)		RBL-2(Audit)	Data Warehousing & Data Mining (3) + Foundations and Perspectives of Sustainable Development (5)		Campus to Corporate (2)		19	
3	V	Environmental Pollution and HumanHealth (3) + Natural Resource Management and Sustainability (5) + **LAB:** Environmental Pollution and HumanHealth (2)	Environmental Legislation and Policy (4)	Land and Soil conservation (3)	RBL-3(1)				Industrial Connect (2)	20	**(120)** BACHELOR IN ENVIRONMENTAL SCIENCE
	VI	Energy and Environment (3) + Water Conservation (5) + **LAB:** Energy andEnvironment (2)	Urban Ecosystems (4)		RBL-4(1)	Multivariate Data Analysis (3)			Community Connect (2)	20	

4	VII	Natural Hazards and Disaster Management (3) + Remote Sensing and GIS (3) + **LAB:** Remote Sensing and GIS (2)		Bioinstrumentation (4) + Solid Waste Management (4)		Non-Parametric Statistical Inference (4)				20	(160) BACHELOR (HONOURS) IN ENVIRONMENTAL SCIENCE
	VIII	Environmental Biotechnology (4) + Environmental Toxicology (4) + Renewable Energy Resources (4)		Environmental Impact and Risk Assessment (4)		Sampling Theory (4)				20	
4	VII	Natural Hazards and Disaster Management (3) + Remote Sensing and GIS (3) + Bioinstrumentation (4) + Solid Waste Management (4) + **LAB:** Remote Sensing and GIS (2)				Non-Parametric Statistical Inference (4)			Project (3)	23	(160) BACHELOR (HONOURS WITH RESEARCH) IN ENVIRONMENTAL SCIENCE
	VIII	Environmental Impact and Risk Assessment (4)				Sampling Theory (4)			Project (9)	17	

3

Teaching Schemes
Programme Structure
Sharda School of Basic Sciences & Research
CERTIFICATE IN BASIC ENVIRONMENTAL SCIENCE
Batch: 2023-27
SEMESTER: I

S.No.	Paper ID	Subject Code	Subjects	Teaching Load			Credits	Core/Elective Pre-Requeste/Co Requisite	Type of Course 1. CC 2. AEC 3. SEC 4. DSE 5.VAC
				L	T	P			
Theory Subject									
1	31668	BEN101	Fundamentals of Environmental Science	4	0	0	4	Core	CC
2	31669	BEN102	Ecology andEcosystems	3	0	0	3	Core	DSE
3		CMS102	Descriptive Statistics	3	0	0	3	Minor/Elective	OE
4	31670	VAC103/ VAC	Environmental Management / Any VAC	3	0	0	3	Co-Requisite	VAC
5	16254	ARP101	Communicative English -1	1	0	2	2	Co Requisite	AEC
Practical/Viva-Voice/Jury									
1	31671	VOE101	Environmental data presentation: Step forward from Laboratory to Industry-I	0	0	6	3	Co Requisite	SEC
2	31672	BEN151	Fundamentals of Environmental Science Lab	0	0	2	1	Co Requisite	CC
3	31673	BEN152	Ecology and Ecosystems Lab	0	0	2	1	Co Requisite	DSE
			TOTAL CREDITS				20		

Teaching Schemes
Programme Structure
Sharda School of Basic Sciences & Research
Certificate In Basic Environmental Science
Batch: 2023-27
SEMESTER: II

S.No.	Paper ID	Subject Code	Subjects	Teaching Load			Credits	Core/Elective Pre-Requeste/Co Requisite	Type of Course 1. CC 2. AEC 3. SEC 4. DSE 5.VAC
				L	T	P			
Theory Subject									
1	31674	BEN103	Water Resources	4	0	0	4	Core	CC
2	31675	BEN104	Biodiversity and Conservation	3	0	0	3	Core	CC
3	31700	CMS132	Mathematical Expectations and Probability Distribution	3	0	0	3	Minor/Elective	OE
4	31701	VAC110/ VAC	Yoga for Holistic health / Any VAC	0	1	4	3	Co-Requisite	VAC
5	16342	ARP102	Communicative English -2	1	0	2	2	Co Requisite	AEC
Practical/Viva-Voice/Jury									
1	31676	VOE102	Environmental data presentation: Step forward fromLaboratory to Industry-II	0	0	6	3	Co Requisite	SEC
2	31677	BEN153	Water ResourceLab	0	0	2	1	Co Requisite	CC
3	31678	BEN154	Biodiversity and Conservation Lab	0	0	2	1	Co Requisite	CC
			TOTAL CREDITS				20		

Programme Structure
Sharda School of Basic Sciences &Research
Diploma In Environmental Science
Batch: 2023-27
SEMESTER: III

S.No.	Paper ID	Subject Code	Subjects	Teaching Load			Credits	Core/Elective Pre-Requeste/Co Requisite	Type of Course 1. CC 2. AEC 3. SEC 4. DSE 5.VAC
				L	T	P			
1	31679	BEN201	Atmosphere andGlobal Climate Change	4	0	0	4	Core	CC
2	31680	BEN202	Analytical Techniques	3	0	0	3	Core	CC
3	31681	BEN203	Environmental Microbiology	3	0	0	3	Minor/Elective	OE
4	31702	BDA217	Data Preparation and Data Cleaning	3	0	0	3	Minor/Elective	OE
5	16977	ARP207	Logical Skills Building & Soft Skills	0	1	2	2	Co Requisite	AEC
1	31682	VOE201	Environmental data presentation: Step forward from Laboratory to Industry-III	0	0	6	3	Co Requisite	SEC
2	31683	BEN251	Atmosphere andGlobal Climate Change Lab	0	0	2	1	Co Requisite	CC
3	31662	BEN252	Analytical Lab I	0	0	2	1	Co Requisite	CC
4	31684	BEN253	Environmental Microbiology Lab	0	0	2	1	Minor/Elective	OE
5	31350	RBL001	Research BasedLearning -1 (RBL1)	0	0	4	0	Co Requisite	DSE
			TOTAL CREDITS				21		

S.No.	Paper ID	Subject Code	Subjects	Teaching Load			Credits	Core/Elective Pre-Requeste/Co Requisite	Type of Course 1. CC 2. AEC 3. SEC 4. DSE 5.VAC
				L	T	P			
Theory Subject									
1	31685	BEN204	Green Technologies	4	0	0	4	Core	CC
2	31686	BEN205	Air Pollution and Technologies	3	0	0	3	Core	CC
3	31687	BEN206	Foundations and Perspectives of Sustainable development	5	0	0	5	Minor/Elective	OE
4	31703	BDA218	Data Warehousing & Data Mining	3	0	0	3	Minor/Elective	OE
5	17035	ARP306	Campus to Corporate	0	1	2	2	Co Requisite	AEC
Practical/Viva-Voice/Jury									
1	31688	BEN254	Analytical Lab II	0	0	2	1	Co Requisite	CC
2	31689	BEN255	Air Pollution and Technologies Lab	0	0	2	1	Co Requisite	CC
3	31456	RBL002	Research Based Learning (RBL2)	0	0	4	0	Co Requisite	DSE
			TOTAL CREDITS				19		

Programme Structure
Sharda School of Basic Sciences & Research
DEGREE IN BACHELOR OF ENVIRONMENTAL SCIENCE
Batch: 2023-27
SEMESTER: V

S.No.	Paper ID	Subject Code	Subjects	Teaching Load			Credits	Core/Elective Pre-Requeste/Co Requisite	Type of Course 1. CC 2. AEC 3. SEC 4. DSE 5.VAC
				L	T	P			
Theory Subject									
1	31690	BEN301	Environmental Pollution and Human Health	3	0	0	3	Core	CC
2	31691	BEN302	Natural Resource Management and Sustainability	5	0	0	5	Core	CC
3	31692	BEN303	Environmental Legislation and Policy	4	0	0	4	Core	CC
4	31693	BEN304	Land and Soil Conservation	3	0	0	3	Core	DSE
Practical/Viva-Voice/Jury									
1	31694	BEN351	Environmental Pollution and Human Health Lab	0	0	4	2	Co Requisite	CC
2	31426	RBL003	ResearchBased Learning (RBL3) Project	0	0	2	1	Co Requisite	DSE
3	31552	INC001	IndustrialConnect	0	0	4	2	Co Requisite	VAC
			TOTAL CREDITS				20		

Programme Structure
Sharda School of Basic Sciences & Research
DEGREE IN BACHELOR OF ENVIRONMENTAL SCIENCE
Batch: 2023-27
SEMESTER: VI

S.No.	Paper ID	Subject Code	Subjects	Teaching Load			Credits	Core/Elective Pre-Requeste/Co Requisite	Type of Course 1. CC 2. AEC 3. SEC 4. DSE 5.VAC
				L	T	P			
Theory Subject									
1	31695	BEN305	Energy and Environment	3	0	0	3	Core	CC
2	31696	BEN306	Water Conservation	5	0	0	5	Core	CC
3	31697	BEN307	Urban Ecosystems	4	0	0	4	Core	CC
4	31704	BDA323	Multivariate Data Analysis	3	0	0	3	Minor/Elective	OE
Practical/Viva-Voice/Jury									
1	31698	BEN353	Energy and Environment Lab	0	0	4	2	Co Requisite	CC
2		CCU	CommunityConnect	0	0	4	2	Co Requisite	VAC
3	31472	RBL004	Research BasedLearning (RBL4) Project	0	0	2	1	Co Requisite	DSE
			TOTAL CREDITS				20		

Programme Structure
Sharda School of Basic Sciences & Research
BACHELOR (HONOURS) IN ENVIRONMENTAL SCIENCE
Batch: 2023-27
SEMESTER: VII

S.No.	Paper ID	Subject Code	Subjects	Teaching Load			Credits	Core/Elective Pre-Requeste/Co Requisite	Type of Course 1. CC 2. AEC 3. SEC 4. DSE 5.VAC
				L	T	P			
Theory Subject									
1	31705	BEN401	Natural Hazardsand Disaster Management	3	0	0	3	Core	CC
2	31706	BEN402	Remote Sensingand GIS	3	0	0	3	Core	CC
3	31707	BEN403	Bioinstrumentation	4	0	0	4	Core	DSE
4	31708	BEN404	Solid Waste Management	4	0	0	4	Core	DSE
5	31709	MDA111	Non-Parametric Statistical Inference	4	0	0	4	Minor/Elective	OE
Practical/Viva-Voice/Jury									
1	31710	BEN451	Remote Sensingand GIS Lab	0	0	4	2	Co Requisite	CC
			TOTAL CREDITS				20		

Programme Structure
Sharda School of Basic Sciences & Research
BACHELOR (HONOURS) IN ENVIRONMENTAL SCIENCE
Batch: 2023-27
SEMESTER: VIII

S.No.	Paper ID	Subject Code	Subjects	Teaching Load			Credits	Core/Elective Pre-Requeste/Co Requisite	Type of Course 1. CC 2. AEC 3. SEC 4. DSE 5.VAC
				L	T	P			
Theory Subject									
1	31711	BEN405	Environmental Impact and Risk Assessment	4	0	0	4	Core	DSE
2	31712	BEN406	Environmental Biotechnology	4	0	0	4	Core	CC
3	31713	BEN407	Environmental Toxicology	4	0	0	4	Core	CC
4	31714	BEN408	Renewable Energy Resources	4	0	0	4	Core	CC
5	31645	BDA214	Sampling Theory	4	0	0	4	Minor/Elective	OE
			TOTAL CREDITS				20		

Programme Structure
Sharda School of Basic Sciences & Research
BACHELOR (HONOURS WITH RESEARCH) IN ENVIRONMENTAL SCIENCE
Batch: 2023-27
SEMESTER: VII

S.No.	Paper ID	Subject Code	Subjects	Teaching Load			Credits	Core/Elective Pre-Requeste/Co Requisite	Type of Course 1. CC 2. AEC 3. SEC 4. DSE 5.VAC
				L	T	P			
Theory Subject									
1	31705	BEN401	Natural Hazardsand Disaster Management	3	0	0	3	Core	CC
2	31706	BEN402	Remote Sensingand GIS	3	0	0	3	Core	CC
3	31707	BEN403	Bioinstrumentation	4	0	0	4	Core	CC
4	31708	BEN404	Solid Waste Management	4	0	0	4	Core	CC
5	31709	MDA111	Non-Parametric Statistical Inference	4	0	0	4	Minor/Elective	OE
Practical/Viva-Voice/Jury									
1	31710	BEN451	Remote Sensingand GIS Lab	0	0	4	2	Co Requisite	CC
2		BEN452	Research Project	0	0	6	3	Co Requisite	VAC
			TOTAL CREDITS				23		

S.No.	Paper ID	Subject Code	Subjects	Teaching Load			Credits	Core/Elective Pre-Requeste/Co Requisite	Type of Course 1. CC 2. AEC 3. SEC 4. DSE 5.VAC
				L	T	P			
Theory Subject									
1	31711	BEN405	Environmental Impact and Risk Assessment	4	0	0	4	Core	CC
2	31645	BDA214	Sampling Theory	4	0	0	4	Minor/Elective	OE
Practical/Viva-Voice/Jury									
1		BEN453	Research Project	0	0	18	9	Co Requisite	VAC
				TOTAL CREDITS			17		

Total credits of the 04-year UG Programme: 160	1st Year	40	
	2nd Year	80	
	3rd Year	120	160
	4th Year	160	

Course Modules

First Year
Detailed syllabus for
Certificate
In
Environmental Sciences

Fundamentals of Environmental Science

School: SSBSR	Batch: 2023-2027
Programme: B.Sc.	Current Academic Year: 2023-2024
Branch: Environmental Sciences	SEMESTER: I

1	Course Code	**BEN101**
2	Course Title	**Fundamentals of Environmental Science**
3	Credits	4
4	Contact Hours (L-T-P)	4-0-0
5	Course Status	Compulsory
6	Max. Marks	15+10+75 = 100
7	Min. Marks	
8	Course Objective	This course provides an opportunity to develop knowledge and understanding of Creating the awareness about environmental problems among people.
9	Course Outcomes	CO1: To define the Imparting basic knowledge about the environment Recognize the difference. CO2: To explain the Environment issue and resolving the environmental problem CO3: Utilize the importance of Environmental CO4: To define the importance of Environmental and what are the impact of human health of Environment pollution CO5: To define the Ecosystem and biodiversity CO6: Understanding and develop the System concept, system analysis, system measurement
10	Course Description	This course provides students full knowledge about the Environment issue and resolving the environmental problem and understand the importance of Environmental and what are the what are the impact of human health of Environment pollution

11	Outline syllabus		CO Mapping
	Unit 1	**Introduction to Environmental Studies**	
	A	History of Environmental Science, Importance of Environmental science, Scope of Environmental Science, Multidisciplinary nature of Environmental Science	CO1
	B	Concept of environmental factors: maximum, minimum and optimum. (Light, Heat, Carbon dioxide and Oxygen)	CO1
	C	Water resources, land resources, soil resources	CO1
	Unit 2	**Components of Environments**	

A	Global Concept of: biosphere, biome, ecosystem.	CO2
B	Subdivisions of the biosphere: lithosphere, atmosphere, hydrosphere	CO2
C	The Biome concept, Principal biomes of the world, Tropical Forest biome, Temperate forest biome, Tundra biome, Desert biome, Grassland biome.	CO2
Unit 3	**Environmental Problem**	
A	Impact of man on the biosphere: Environmental problems,	CO3
B	Global warming, Ozone depletion and Acid rain	CO3
C	Human population growth, Age structure and significance, Human Population and environmental impact, Population and its impact on resources.	CO3
Unit 4	**Concept of Ecosystem**	
A	Concepts pertaining to the ecosystem. Comparison of ecosystem through number	CO4, CO6
B	Ecosystem organization, food chains, food web. Biomass and energy pyramids.	CO4, CO6
C	Structural and functional. Concept of trophic levels.	CO4, CO6
Unit 5	**Impact of Man on Ecosystems**	
A	System concept, system analysis, system measurement.	CO5, CO6
B	Concept of ecosystem dynamics; stability of ecosystems and control	CO5, CO6
C	Mechanisms: homeostasis, homeorhesis, microcosms and mesocosms.	CO5, CO6
Mode of examination	20 marks for Test / Quiz / Assignment / Seminar.05 marks for Class Interaction	
Weightage Distribution	CA	MSE	ESE	
	15	10	75	
Text book/s*	1. Lave, Lester B., Hendrickson, Chris T., and McMichael, Francis Clay. 1995. 'Environmental implications of electric cars,' Science, 268, 993–995. 2. L'hirondel, Jean-Louis. 1999. 'Are dietary nitrates a threat to human health?', in Morris, Julian and Bate, Roger (eds) Fearing Food, Butterworth Heinemann, Oxford, pp. 38–46. Mason, C.F. 1991. 3. Biology of Freshwater Pollution, 2nd edn. Longman Scientific and Technical, Harlow, Essex. Meadows, Donella H., Meadows, Dennis L., Randers, Jorgen, and Behrens, William W. III. 1972. The Limits to Growth. Earth Island, London.	
Suggestive Digital Platforms / Web Links	Moore, Peter D. 1995. 'Too much of a good thing', Nature, 374, 117–118. Piel, Gerard. 1992. Only One World. W. H. Freeman, New York. Raven, Peter H., Berg, Linda R., and Johnson, George B. 1993. Environment. Saunders College Publishing, Orlando, Florida. Reinhold, Robert. 1992. 'The lingering US drought,' Britannica Book of the Year 1992. Encyclopaedia Britannica,	

Course Articulation Matrix

Cos	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3
CO1	3	3	2	1	3	1	1	3	3	2	2	3	1	-
CO2	3	3	2	1	3	1	1	3	3	2	2	3	1	-
CO3	3	3	2	1	3	1	1	3	3	2	2	3	1	-
CO4	3	3	2	1	3	1	1	3	3	2	2	3	1	-
CO5	3	3	2	1	3	1	1	3	3	2	2	3	1	-
CO6	3	3	2	1	3	1	1	3	3	2	2	3	1	-

1-Slight (Low)   2-Moderate (Medium)   3-Substantial (High)

Ecology and Ecosystems

School: SSBSR	Batch: 2023-2027	
Programme: B.Sc.	Current Academic Year: 2023-2024	
Branch: Environmental Sciences	SEMESTER: I	
1	Course Code	**BEN102**
2	Course Title	**Ecology and Ecosystems**
3	Credits	3
4	Contact Hours (L-T-P)	3-0-0
4	Course Status	Compulsory
5	Max. Marks	15+10 +75= 100
6	Min. Marks	
7	Course Objective	This paper will introduce to the students the basic understanding of ecosystem and its structural and functional aspects.
8	Course Outcomes	CO1: Demonstrate sound understanding on scientific inquiry in the field of modern ecology. CO2: Describe the characteristics of population and modals of population growth. CO3: Explain the link between community composition and ecosystem functions. CO4: Describe the characteristics of the major biomes and ecosystems of the Earth. CO5: Describe and relate biogeochemical cycles with elements of the atmosphere, the biosphere, the hydrosphere, the pedosphere and the lithosphere. CO6: Describe the basic principles of ecology, including population ecology, community ecology, and ecosystem function.
9	Course Description	It will explore the interconnectedness among all the biotic and abiotic components of environment and the dynamic nature of the ecological processes in maintaining equilibrium in nature.
10	Outline syllabus	CO Mapping
	Unit 1	**Introduction to Ecology**	
	A	Basic concepts and definitions: ecology, landscape, habitat, ecozones, biosphere, ecosystems, ecosystem stability	CO1
	B	Autecology; synecology; major terrestrial biomes. Ecological amplitude; phenotypic plasticity	CO1

C	Ecoclines; acclimation; ecological niche; types of niches: fundamental niche; niche breadth; niche partitioning; niche differentiation	CO1
Unit 2	**Population Ecology**	
A	Concept of population and meta-population; r- and K-selection; characteristics of population: density, dispersion, natality, mortality	CO2
B	Life tables, survivorship curves, age structure; population growth: exponential, logistic, density-dependent; limits to population growth	CO2
C	Deterministic and stochastic models of population dynamics; competitive and stress-tolerance strategies	CO2
Unit 3	**Community Ecology**	
A	Discrete versus continuum community view; community structure and organization: biomass, stability, keystone species	CO3/ CO6
B	Species interactions: mutualism, symbiotic relationships, commensalism, amensalism, predation, competition, parasitism	CO3/ CO6
C	Ecological succession: primary and secondary successions, models and types of successions, climax community concepts, examples of succession	CO3/ CO6
Unit 4	**Ecosystem Ecology**	
A	Types of ecosystems: forest, grassland, lentic, lotic, desert, ecosystem structure and function; abiotic and biotic components of ecosystem; ecosystem. function; primary production and models of energy flow	CO4/ CO6
B	Secondary production and trophic efficiency; ecosystem connections: food chain, food web; detritus pathway of energy flow and decomposition processes; ecological pyramids: pyramids of number	CO4/ CO6
C	Concept of exotics and invasives; natural spread versus man-induced invasions; characteristics of invaders; stages of invasion; mechanisms of invasions; invasive pathways; impacts of invasion on ecosystem and communities	CO4/ CO6
Unit 5	**Biogeochemical Cycles and Nutrient Cycling**	
A	Carbon cycle; Nitrogen cycle; Phosphorus cycle; Sulphur cycle; Hydrological cycle; Nutrient Cycle Models	CO5/ CO6
B	Ecosystem input of nutrients; biotic accumulation; ecosystem losses; nutrient supply and uptake	CO5/ CO6
C	Decomposition and nutrient release; nutrient use efficiency; nutrient budget; nutrient conservation strategies	CO5/ CO6
Mode of examination	20 marks for Test / Quiz / Assignment / Seminar. 05 marks for Class Interaction	

Weightage Distribution	CA	MSE	ESE	
	15	10	75	
Text book/s*	1. Groom. B. & Jenkins. M. 2000.Global Biodiversity: Earth's Living Resources in the 21st Century. World Conservation Press, Cambridge, UK. 2. Gurevitch, J., Scheiner, S. M., & Fox, G. A. 2002. The Ecology of Plants. Sinauer associates incorporated. 3. Loreau, M. & Inchausti, P. 2002. Biodiversity and Ecosystem functioning: Synthesis and Perspectives. Oxford University Press, Oxford, UK. 4. Pandit, M.K., White, S.M.& Pocock, M.J.O. 2014. The contrasting effects of genome size, chromosome number and ploidy level on plant invasiveness: a global analysis. New Phytologist 203: 697-703.			

Course Articulation Matrix

Cos	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3
CO1	3	3	2	1	3	1	1	3	3	2	2	3	1	-
CO2	3	3	2	1	3	1	1	3	3	2	2	3	1	-
CO3	3	3	2	1	3	1	1	3	3	2	2	3	1	-
CO4	3	3	2	1	3	1	1	3	3	2	2	3	1	-
CO5	3	3	2	1	3	1	1	3	3	2	2	3	1	-
CO6	3	3	2	1	3	1	1	3	3	2	2	3	1	-

1-Slight (Low)   2-Moderate (Medium)   3-Substantial (High)

Descriptive Statistics

School: SSBSR	Batch: 2023-27	
Programme: B.Sc.	Academic Year: 2023-24	
Branch: Environmental Sciences	Semester: I	
1	Course Code	**CMS102**
2	Course Title	**Descriptive Statistics**
3	Credits	3
4	Contact Hours(L-T-P)	3-0-0
	Course Status	DSE
5	Course Objective	1. To introduce basic statistical concepts, logic and analytical tools, analyze and communicate quantitative data verbally, graphically, symbolically, and numerically. 2. To make students familiar with the concept of Probability and Statistics and display data utilizing various tables, charts, and graphs.
6	Course Outcomes	CO1: Describe the process and particular steps in designing studies, collecting and analyzing data, interpreting and presenting results; and developing skills in presenting quantitative data using appropriate diagrams, tabulations, and summaries. (K2, K5). CO2: Describe the properties of discrete and continuous distribution functions. (K2). CO3: Calculate the measures of central tendency and dispersion of data and describe the method used for analysis, including a discussion of advantages, disadvantages, and necessary assumptions. (K2, K3) CO4: Calculate and interpret the correlation between two variables, Calculate the simple linear regression equation for a set of data and know the basic assumptions behind regression analysis. (K2,K3). CO5: Understand the line of best fit as a tool for summarizing a linear relationship and predicting future observed values, and develop the ability to use formal mathematical argument in the context of probability. (K2, K5) CO6: Develop the skills to interpret the results of statistical analysis. (K2, K5).
7	Course Description	This is an introductory course in statistics. Students are introduced to the fundamental concepts involved in using sample data to make inferences about populations. Included are the study of measures of central tendency and dispersion, finite probability, statistical inferences from large and small samples, linear regression, and correlation.

8	**Outline syllabus**		**CO Mapping**
	Unit 1	**Presentation of data**	
	A	Classification, tabulation, diagrammatic & graphical representation of grouped data.	CO1
	B	Frequency distributions, cumulative frequency distributions	CO1
	C	Histogram, Ogives, frequency polygon, Tree and leaf diagram.	CO1
	Unit 2	**Descriptive statistics**	CO2
	A	Measures of central tendency – arithmetic mean, median, quartiles, mode, harmonic mean, geometric mean.	CO2
	B	Their properties, merits, and demerits	CO2
	C	Measures of dispersion, range, quartile deviation, mean deviation, standard deviation, and coefficient of variation.	
	Unit 3	**Moments**	CO3

A	Moments, Skewness, Measures of skewness: Karl Pearson's coefficient of skewness.	CO3
B	Quartile, coefficient of skewness, Measure of skewness based on moments.	CO3
C	Kurtosis, Measures of Kurtosis.	
Unit 4	**Bi-variate data analysis**	CO4
A	Bivariate data, principles of least squares, fitting of polynomial curves, and fitting of curves reducible to polynomial form.	CO4
B	Correlation: Spearman's rank correlation, Partial and Multiple Correlation (only two independent variables case).	CO4
C	Regression lines.	
Unit 5	**Probability**	CO5
A	Probability: Introduction, random experiment, outcomes, sample space, events, various definitions of probability, laws of total and compound probability.	CO5
B	Boole's inequality. Conditional probability, independence of events.	CO5
C	Bayes theorem and its applications in real-life problems.	CO6
Mode of examination	Theory	
Weightage Distribution	CA: 15%; MTE: 10%; ETE:75%	
Text book/s*	1. Gupta, S.C. and Kapoor, V.K., "Fundamentals of Mathematical Statistics".	
Other References	1. Daniel, Wayne W., "Biostatistics": Basic concept and Methodology for Health Science. 2. Grewal, B.S, "Higher Engineering Mathematics". 3. Rohatgi, V.K. Introduction to Probability.	

Course Articulation Matrix

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	1	2	-	1	-	-	-	-	-	-	-	-	-
CO2	3	1	2	-	1	-	-	-	-	-	-	-	-	-
CO3	3	1	2	-	1	-	-	-	-	-	-	-	-	-
CO4	3	1	2	-	1	-	-	-	-	-	-	-	-	-
CO5	3	1	2	-	1	-	-	-	-	-	-	-	-	-
CO6	3	1	2	-	1	-	-	-	-	-	-	-	-	-

1-Slight (Low)   2-Moderate (Medium)   3-Substantial (High)

School: SSBSR	Batch: 2023-2027
Programme: B.Sc.	Current Academic Year: 2023-2024
Branch: Environmental Sciences	SEMESTER: I

1	Course Code	**VOE101**
2	Course Title	**Environmental data presentation: Step forward from laboratory to industry-I**
3	Credits	3
4	Contact Hours (L-T-P)	0-0-6
5	Course Status	Compulsory
6	Max. Marks	25+25+50 = 100
7	Min. Marks	
8	Course Objective	Students will have the knowledge and skills to understand the various laboratory methods related to common laboratory practices. They will understand procedure of how to use the various laboratory techniques, safe handling of chemicals and glass wares, and prepare and purify certain chemical of industrial importance.
9	Course Outcomes	Upon successful completion of course, students will be able to CO1 Understand the use of protective apparel and first aid. CO2 Understand the safe disposal of chemicals in laboratory CO3 Determine melting and boiling points of chemicals. CO4 Assemble different laboratory apparatus.CO5 Able to recrystallize compounds. CO6 Able to handle the process in a laboratory.
10	Course Description	This course provides students full knowledge about the Environment issue and resolving the environmental problem and understand the importance of Environmental and what are the what are the impact of human health of Environment pollution

11	Outline syllabus		CO Mapping
	Unit 1	**Chemical safety and ethical handling of chemicals**	
	A	Safe working procedure and protective environment, Protective apparel, emergency procedure and first aid, laboratory ventilation.	CO1

B & C	Safe storage and use of hazardous chemical, procedure forworking with substances that pose hazards, flammable or explosive hazards, Material safety data sheet.	CO1
Unit 2	**Storage and disposal**	
A	Procedures for working with gasses at pressures above or below atmospheric- safe storage and disposal of waste chemicals, recovery, recycling and reuse of laboratory chemicals	CO2
B & C	Procedure for laboratory disposal of explosives, identification, verification and segregation of laboratorywaste, disposal of chemicals in the sanitary sewer system, incineration and transportation of hazardous chemicals.	CO2
Unit 3	**Introduction to Spectrophotometry**	
A	Blackbody radiation or What's the difference between a light bulb an LED and the sun?	CO3
B & C	Spectroscopy trading rules: Signal-to-Noise, Resolution, Ensemble Averaging, Digital Smoothing	CO3
Unit 4	**UV- Visible Spectroscopy**	
A	Preparation of calibration curve.	CO4
B & C	Verification of Beer – Lambert Law for $KMnO_4/K_2Cr_2O_7$ and determination of concentration of the given solution of the substance from absorption measurement.	CO4
Unit 5	**Spectroscopy (IR)**	
A	Assignment of labelled peaks in the IR spectrum of the same compound explaining the relative frequencies of the absorptions (C-H, O-H, N-H, C-O, C-N, C-X, C=C, C=O, N=O, C≡C, C≡N stretching frequencies; characteristic bending vibrations are included. (Spectra to be provided)	CO5, CO6
B & C	Identification of simple organic compounds by IR spectroscopy. (Spectra to be provided).	CO5, CO6
Mode of examination	20 marks for Test / Quiz / Assignment / Seminar.05 marks for Class Interaction	
Weightage Distribution	CA	CE	ESE	
	25	25	50	
Text book/s*	Mendham, J. Vogel's Quantitative Chemical Analysis, Pearson, 2009. Harris, D. C. Quantitative Chemical Analysis. 6th Ed., Freeman (2007) Chapters 3-5. Harris, D. C. *Exploring Chemical Analysis*, 9th Ed. New York, W.H. Freeman, 2016. A text-book of practical organic chemistry including qualitative organic analysis byVogel, 3rd Edition.	

	Suggestive Digital Platforms / Web Links	1. https://www.researchgate.net/publication/268049349_ Development_of_a_Standardized_Procedure_for_Cleaning_Glass _Apparatus_in_Analytical_Laboratories 2. https://www.vlab.co.in/broad-area-chemical-sciences http://chemcollective.org/vlabs	

Course Articulation Matrix

Cos	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3
CO1	3	3	2	1	3	1	1	3	3	2	2	3	1	1
CO2	3	3	2	1	3	1	1	3	3	2	2	3	1	1
CO3	3	3	2	1	3	1	1	3	3	2	2	2	1	1
CO4	3	3	2	1	3	1	1	3	3	2	2	2	1	1
CO5	3	3	2	1	3	1	1	3	3	2	2	3	1	1
CO6	3	3	2	1	3	1	1	3	3	2	2	3	1	1

1-Slight (Low)   **2-Moderate (Medium)**   **3-Substantial (High)**

Communicative English -1

Schools: SSBSR		**Batch :** 2023-2027	
		Academic Year: 2023-2024	
		Semester: I	
1	**Course Code**	**ARP101**	
2	**Course Title**	Communicative English-1	
3	**Credits**	2	
4	**Contact Hours (L-T-P)**	0-1-2	
5	Course Objective	To minimize the linguistic barriers that emerges in varied socio-linguistic environments through the use of English. Help students to understand different accents and standardise their existing English. Guide the students to hone the basic communication skills - listening, speaking, reading and writing while also uplifting their perception of themselves, giving them self-confidence and building positive attitude.	
6	Course Outcomes	After completion of this course, students will be able to: CO1 Develop a better understanding of advanced grammar rules and write grammatically correct sentences CO2 Acquire wide vocabulary and punctuation rules and learn strategies for error-free communication. CO3 Interpret texts, pictures and improve both reading and writing skills which would help them in their academic as well as professional career CO4 Comprehend language and improve speaking skills in academic and social contexts CO5 Develop, share and maximise new ideas with the concept of brainstorming and the documentation of key critical thoughts articulated towards preparing for a career based on their potentials and availability of opportunities. CO6 Function effectively in multi-disciplinary teams through the knowledge of team work, Inter-personal relationships, conflict management and leadership quality	
7	Course Description	The course is designed to equip students, who are at a very basic level of language comprehension, to communicate and work with ease in varied workplace environment. The course begins with basic grammar structure and pronunciation patterns, leading up to apprehension of oneself through written and verbal expression as a first step towards greater employability.	
8		Outline syllabus – ARP 101	
	Unit A	**Sentence Structure**	**CO Mapping**
	Topic 1	Subject Verb Agreement	CO1
	Topic 2	Parts of speech	CO1
	Topic 3	Writing well-formed sentences	CO1
	Unit B	**Vocabulary Building & Punctuation**	
	Topic 1	Homonyms/ homophones, Synonyms/Antonyms	CO1, CO2
	Topic 2	Punctuation/ Spellings (Prefixes-suffixes/Unjumbled Words)	CO1, CO2
	Topic 3	Conjunctions/Compound Sentences	CO1, CO2
	Unit C	**Writing Skills**	
	Topic 1	Picture Description – Student Group Activity	CO3

Topic 2	Positive Thinking - Dead Poets Society-Full-length feature film - Paragraph Writing inculcating the positive attitude of a learner through the movie | SWOT Analysis – Know yourself	CO3, CO2, CO3
Topic 3	Story Completion Exercise –Building positive attitude - The Man from Earth (Watching a Full length Feature Film)	CO2, CO3
Topic 4	Digital Literacy | Effective Use of Social Media	CO3
Unit D	**Speaking Skill**	
Topic 1	Self-introduction/Greeting/Meeting people – Self branding	CO4
Topic 2	Describing people and situations - To Sir With Love (Watching a Full length Feature Film)	CO4
Topic 3	Dialogues/conversations (Situation based Role Plays)	CO4
Unit E	**Professional Skills | Career Skills**	
Topic 1	Exploring Career Opportunities	CO4, CO5
Topic 2	Brainstorming Techniques & Models	CO4, CO5
Topic 3	Social and Cultural Etiquettes	CO4, CO5
Topic 4	Internal Communication	CO4, CO5
Unit F	**Leadership and Management Skills**	
Topic 1	Managerial Skills	CO6
Topic 2	Entrepreneurial Skills	CO6

9.	Evaluations	*Class Assignments/Free Speech Exercises / JAM Group Presentations/Problem Solving Scenarios/GD/Simulations (60% CA and 40% ETE*	*N/A*
10.	Texts & References | Library Links	• Blum, M. Rosen. *How to Build Better Vocabulary*. London: Bloomsbury Publication • Comfort, Jeremy (et.al). *Speaking Effectively*. Cambridge University Press	

Course Articulation Matrix

Cos	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3
CO1	2	1	1	3	-	-	-	-	-	-	-	-	-	-
CO2	2	1	1	3	-	-	-	-	-	-	-	-	-	-
CO3	2	1	1	3	-	-	-	-	-	-	-	-	-	-
CO4	2	1	1	3	-	-	-	-	-	-	-	-	-	-
CO5	2	1	1	3	-	-	-	-	-	-	-	-	-	-
CO6	2	1	1	3	-	-	-	-	-	-	-	-	-	-

1-Slight (Low)   **2-Moderate (Medium)**   **3-Substantial (High)**

School: SSBSR	**Batch: 2023-2027**	
Programme: All	**Current Academic Year: 2023-24**	
Branch: All	**Semester: I**	
1	**Course Code**	**VAC103**
2	Course Title	Environmental Management
3	Credits	03
4	Contact Hours (L-T-P)	3-0-0
	Course Status	Compulsory
5	Course Objective	1. Enable students to learn the concepts, principles and importance of environmental science 2. Provide students an insight of various causes of natural resource depletion and its conservation 3. Provide detailed knowledge of causes, effects and control of different types of environmental pollution and its effect on climate change, global warming and ozone layer depletion. 4. Provide knowledge of different methods of water conservation 5. Provide and enrich the students about sustainable practices and environmental management
6	Course Outcomes	CO1.Develop a better understanding of the principles and scope of environmental science CO2. Acquire to learn various pollution causes, effects and control and solid waste management. CO3. Interpret the effect of global warming and ozone layer depletion CO4. Comprehend about various types of natural resources and its conservation CO5. Develop a better understanding about sustainable practices and environmental management CO6. Function effectively on overall understanding of various environmental components, its protection and management.
7	Course Description	Environmental Science emphasises on various factors as 1. Importance and scope of environmental science 2. Natural resource conservation 3. Pollution causes, effects and control methods 4. Sustainable and Environmental environment

8	Outline syllabus		CO Mapping
	Unit 1	**Natural resource management**	
	A	Introduction to Natural Resources	CO1
	B	Management of Land and Forest Resources	CO1

C	Water and Energy resource Management	CO1	
Unit 2	**Environmental Pollution Management**		
A	Air pollution Control and Water Pollution treatment Methods	CO2	
B	Soil and Noise Pollution Management	CO2	
C	Solid waste management	CO2	
Unit 3	**Climate Change Mitigation**		
A	Concept of Global Warming and greenhouse effect	CO3/CO6	
B	Ozone layer Depletion and its consequences	CO3/CO6	
C	Climate change, its effect on ecosystem and its mitigation. Kyoto protocol and IPCC concerns on changing climate.	CO3/CO6	
Unit 4	**Biodiversity Management**		
A	Hot spots, Endangered and endemic species of India	CO4/CO6	
B	Threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts, biological invasions	CO4/CO6	
C	Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity.	CO4/CO6	
Unit 5	**Sustainable practices and environmental management**		
A	Sustainable development and sustainable consumption	CO5/CO6	
B	Environmental Issues and Management in India	CO5/CO6	
C	Environmental Management System (EMS)	CO5/CO6	
Mode of examination	Theory based survey		
Weightage Distribution	CA	MSE	ESE
	15	10	75
Text book/s*	Textbook of Environmental Studies for Undergraduate Courses by Erach Bharucha, Pub: Orient Blackswan Pvt Ltd		
Other References	Environmental Science by G. Tyler Miller, JR. and Scott E. Spoolman; Broks/Cole.		

Course Articulation Matrix

Cos	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3	PSO 4
CO1	3	3	2	1	3	1	1	3	3	2	2	2	1	1	-
CO2	3	3	2	1	3	1	1	3	3	2	2	2	1	1	-
CO3	3	3	2	1	3	1	1	3	3	2	2	2	1	1	-
CO4	3	3	2	1	3	1	1	3	3	2	2	2	1	1	-
CO5	3	3	2	1	3	1	1	3	3	2	2	2	1	1	-
CO6	3	3	2	1	3	1	1	3	3	2	2	2	1	1	-

1-Slight (Low)   2-Moderate (Medium)   3-Substantial (High)

Fundamentals of Environmental Science Lab

School: SSBSR	Batch: 2023-2027	
Programme: B.Sc.	Current Academic Year: 2023-24	
Branch: Environmenta lSciences	SEMESTER: I	
1	Course Code	**BEN151**
2	Course Title	**Fundamentals of Environmental Science Lab**
3	Credits	1
4	Contact Hours (L-T-P)	0-0-2
4	Course Status	Compulsory
5	Max. Marks	25+25+50 = 100
6	Min. Marks	
7	Course Objective	Ability to assess the environmental problem
8	Course Outcomes	CO1: Understand and identify the common species of plants CO2: Ability to prepare the audit CO3: Understand the segregation of solid waste CO4: Be familiar with the identification of environmental problemCO5: Ability to identify the sources of pollution CO6: Overall understand the environmental problem
9	Course Description	Approaches for assessing the soil bulk density and irrigation methodsand hydrograph analysis
10	Outline syllabus		CO Mapping
	Unit 1	**Identification of common species of plants**	
	A	Identify five common species of Trees / plants from your neighborhood and list their common names.	CO1
	B and C	Describe each plant in terms of its height and leaves	CO1
	Unit 2	**Preparation of energy audit**	
	A	To Make an audit of the electrical energy consumption by varioushousehold appliances.	CO2

B and C	To compare the energy audit of different appliances	CO2
Unit 3	**Segregation of solid waste and its effect on ecosystem**	
A	To segregate domestic waste into bio-degradable and non-biodegradable components.	CO3/CO6
B and C	To identify the impact of non-biodegradable waste on ecosystem	CO3/CO6
Unit 4	**Identification of environmental problem**	
A	Describe the environmental problem of your locality	CO4/CO6
B and C	Suggest a remedy for the identified environmental problem	CO4/CO6
Unit 5	**Identification of sources of pollution**	
A	Identifying the sources of pollution in surface water obtained fromdifferent sources.	CO5/CO6
B and C	Identifying the sources of pollution in ground water obtained fromdifferent sources.	CO5/CO6
Mode of examination	20 marks for Test / Quiz / Assignment / Seminar.05 marks for Class Interaction	

Weightage Distribution	CA	CE	ESE	
	25	25	50	

Text book/s*	1. *Ramesh Thatikunta, Environmental science - A practical manual, April 2018, Publisher: BS Publications, ISBN:9788178002286* 2. *Janet MacFall, Patricia Thomas-Laemont, Catherine Deininger.* Environmental science - A practical manual, Edition: Copyright:2017. Pages: 182	

Course Articulation Matrix

Cos	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3
CO1	3	3	2	1	3	1	1	3	3	2	2	3	1	-
CO2	3	3	2	1	3	1	1	3	3	2	2	3	1	-
CO3	3	3	2	1	3	1	1	3	3	2	2	3	1	-
CO4	3	3	2	1	3	1	1	3	3	2	2	3	1	-
CO5	3	3	2	1	3	1	1	3	3	2	2	3	1	-
CO6	3	3	2	1	3	1	1	3	3	2	2	3	1	-

1-Slight (Low)   **2-Moderate (Medium)**   **3-Substantial (High)**

Ecology and Ecosystems Lab

School: SSBSR	Batch: 2023-2027	
Programme: B.Sc.	Current Academic Year: 2023-2024	
Branch: ENVIRONMEN TALSCIENCE	SEMESTER: I	
1	Course Code	**BEN152**
2	Course Title	**Ecology and Ecosystems Lab**
3	Credits	1
4	Contact Hours (L-T-P)	0-0-2
4	Course Status	Compulsory
5	Max. Marks	25+25+50 = 100
6	Min. Marks	
7	Course Objective	This paper will introduce to the students the basic understanding of ecosystem and its structural and functional aspects.
8	Course Outcomes	CO1: Knowledge to use practical and analytical techniques to examine population size. CO2: skills to quantify population dynamics. CO3: Explain the link between community composition and ecosystem functions. CO4: Describe the characteristics of the major biomes and ecosystems of the Earth. CO5: Demonstrate steps of Ecological Succession. CO6: Describe the basic principles of ecology, including population ecology, community ecology, and ecosystem function.
9	Course Description	It will explore the interconnectedness among all the biotic and abiotic components of environment and the dynamic nature of the ecological processes in maintaining equilibrium in nature.

10	Outline syllabus		CO Mapping
	Unit 1	**Analysis of Tree Structure**	
	A	Analyze the population structure of tree species in a given area.	CO1

B and C	Estimate the standing forest floor litter.	CO1
Unit 2	**Population Estimation: Capture and Recapture Techniques**	
A	Estimate the biomass and carbon stock of woody vegetation by non-harvest method.	CO2
B and C	Assess the population size by capture and recapture technique	CO2
Unit 3	**Identification of Plants**	
A	Identification of xerophytic plants	CO3/CO6
B and C	Identification of hydrophytic plants	CO3/CO6
Unit 4	**Collection Process of Fauna & Flora**	
A	Collection of fauna from wetland and diversity analysis	CO4/CO6
B and C	Collection of flora from wetland and diversity analysis	CO4/CO6
Unit 5	**Seed Germination**	
A	Seed germination for competition experiment.	CO5/CO6
B and C	Demography of campus tree	CO5/CO6
Mode of examination	20 marks for Test / Quiz / Assignment / Seminar. 05 marks for Class Interaction	

Weightage Distribution	CA	CE	ESE	
	25	25	50	
Text book/s*	1. Groom. B. & Jenkins. M. 2000.Global Biodiversity: Earth's Living Resources in the 21st Century. World Conservation Press, Cambridge, UK. 2. Gurevitch, J., Scheiner, S. M., & Fox, G. A. 2002. The Ecology of Plants. Sinauer associates incorporated. 3. Loreau, M. & Inchausti, P. 2002. Biodiversity and Ecosystem functioning: Synthesis and Perspectives. Oxford University Press, Oxford, UK.				

Course Articulation Matrix

Cos	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3
CO1	3	3	2	1	3	1	1	3	3	2	2	1	-	-
CO2	3	3	2	1	3	1	1	3	3	2	2	1	-	-
CO3	3	3	2	1	3	1	1	3	3	2	2	1	-	-
CO4	3	3	2	1	3	1	1	3	3	2	2	1	-	-
CO5	3	3	2	1	3	1	1	3	3	2	2	1	-	-
CO6	3	3	2	1	3	1	1	3	3	2	2	1	-	-

1-Slight (Low)   2-Moderate (Medium)   3-Substantial (High)

Water Resources

School: SSBSR	Batch: 2023-2027
Programme: B.Sc.	Current Academic Year: 2023-2024
Branch: Environmental Sciences	SEMESTER: II

1	Course Code	**BEN103**
2	Course Title	**Water Resources**
3	Credits	4
4	Contact Hours (L-T-P)	4-0-0
4	Course Status	Compulsory
5	Max. Marks	15+10+75 = 100
6	Min. Marks	
7	Course Objective	This course provides an opportunity to develop knowledge and understanding of water resources and tits properties
8	Course Outcomes	CO1: to define the water resources. CO2: To understand and explain the hydrological cycle. CO3: To learn and identify the properties of water. CO4: To able and analysis the water resources and treatment of water technology CO5: To define the wetlands CO6: to develop the knowledge about the water resources and properties of water.
9	Course Description	This course provides students a full exposure to the basic knowledge about the DO, COD, BOD, electrical conductivity, sodium adsorption ratio; Biological:

10	Outline syllabus		CO Mapping
	Unit 1	**Water resource**	
	A	Sources and types of water;	CO1
	B	Hydrological cycle; precipitation, runoff, infiltration, evaporation,	CO1
	C	Evapotranspiration; classification of water resources (oceans, rivers, lakes and wetlands).	CO1
	Unit 2	**Properties of water**	

A	Physical: temperature, colour, odour, total dissolved solids and total suspended solids; Chemical: major inorganic and organic constituents, dissolved gases		CO2
B	DO, COD, BOD, electrical conductivity, sodium adsorption ratio; Biological:		CO2
C	phytoplankton, phytobenthos, zooplankton, macro-invertebrates and microbes		CO2
Unit 3	**Surface and Groundwater**		
A	Introduction to surface and ground water; water table; vertical distribution of water; formation and properties of aquifers; hydraulic potential, Darcy's equation, types of flow,		CO3
B	turbulence, techniques for ground water recharge; watershed and drainage basins		CO3
C	importance of watershed and watershed management.		CO3, CO6
Unit 4	**Wetlands and Their Management**		
A	Definition of a wetland; types of wetlands (fresh water and marine); ecological and hydrological functions of wetlands;		CO4, CO6
B	Threats to wetlands; wetland conservation and management; Ramsar Convention,		CO4, CO6
C	Major wetlands of India.		CO4, CO6
Unit 5	**Water Resource in India and Water Sharing Conflicts**		
A	Demand for water (agriculture, industrial, domestic); overuse and depletion of surface and ground water resources; water quality standards in India; hot spots of surface water; role of state in water resources management. Water resources and sharing problems,case studies on Kaveri and Krishna river water		CO5, CO6
B	disputes; Multi- purpose river valley projects in India and their environmental and social impacts; case		CO5, CO6
C	studies of dams - Narmada and Tehri dam - social and ecological losses versus economic benefits.		CO5, CO6
Mode of examination	20 marks for Test / Quiz / Assignment / Seminar. 05 marks for Class Interaction		
Weightage Distribution	CA	MSE	ESE
	15	10	75
Text book/s*	Larry W. Mays is Professor in the Civil, Environmental, and Sustainable Engineering Group in the School of Sustainable Engineering and the Build Environment at ...		

Course Articulation Matrix

Cos	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3
CO1	3	3	2	1	3	1	1	3	3	2	2	2	-	-
CO2	3	3	2	1	3	1	1	3	3	2	2	2	-	-
CO3	3	3	2	1	3	1	1	3	3	2	2	2	-	-
CO4	3	3	2	1	3	1	1	3	3	2	2	2	-	-
CO5	3	3	2	1	3	1	1	3	3	2	2	2	-	-
CO6	3	3	2	1	3	1	1	3	3	2	2	2	-	-

1-Slight (Low)   **2-Moderate (Medium)**   **3-Substantial (High)**

Biodiversity and conservation

School: SSBSR		**Batch: 2023-2027**	
Programme: B.Sc.		**Current Academic Year: 2023-2024**	
Branch: Environme ntal Sciences		**SEMESTER: II**	
1	Course Code	**BEN104**	
2	Course Title	**Biodiversity and conservation**	
3	Credits	3	
4	Contact Hours (L-T-P)	3-0-0	
4	Course Status	Compulsory	
5	Max. Marks	15+10+75 = 100	
6	Min. Marks		
7	Course Objective	It helps students to understand and appreciate various concepts and issues concerning biodiversity and conservation at local, regional and global levels.	
8	Course Outcomes	CO1: Articulate why society strives to conserve biodiversity. CO2: Analyzing and evaluating the importance of biological processes on conservation of biodiversity CO3: Identify key threats to biodiversity. CO4: Evaluate which management options are likely to be effective for conservingbiodiversity in different settings. CO5: Identify the rich heritage of India CO6: understanding of biodiversity and conservation biology that is highly valuable both for scientific and management purposes	
9	Course Description	The course will attempt at encouraging students to appreciate the paradigm "thinkglobally, act locally" for a sustainable common future of humankind.	
10	Outline syllabus		CO Mapping
	Unit 1	**Biodiversity patterns and estimation**	
	A	Definition; Types; Spatial patterns: latitudinal and elevational trends in biodiversity; temporal patterns: seasonal fluctuations in biodiversity patterns	CO1
	B	Sampling strategies and surveys: floristic, faunal, and aquatic; qualitative and quantitative methods: scoring, habitat assessment,	CO1

	richness, density, frequency, abundance, evenness, diversity	
C	Biomass estimation; community diversity estimation: alpha, betaand gamma diversity	CO1
Unit 2	**Importance of biodiversity**	
A	Economic values - medicinal plants, drugs, fisheries and livelihoods; ecological services - primary productivity	CO2
B	Role in hydrological cycle, biogeochemical cycling; ecosystem services - purification of water and air, nutrient cycling, climate control, pest control	CO2
C	Pollination, and formation and protection of soil; social, aesthetic, consumptive, and ethical values of biodiversity	CO2
Unit 3	**Threats to biodiversity**	
A	Natural and anthropogenic disturbances; habitat loss, habitatdegradation, and habitat fragmentation; climate change	CO3/ CO6
B	Pollution; hunting; over-exploitation; deforestation; hydropower development; invasive species; land use changes; overgrazing	CO3/ CO6
C	Man wildlife conflicts; consequences of biodiversity loss; Intermediate Disturbance Hypothesis	CO3/ CO6
Unit 4	**Conservation of biodiversity**	
A	Importance of biodiversity patterns in conservation; In-situ conservation (Biosphere Reserves, National Parks, Wildlife Sanctuaries)	CO4/ CO6
B	Ex-situ conservation (botanical gardens, zoological gardens, gene banks, seed and seedling banks, pollen culture, tissue culture and DNA banks), role of local communities and traditional knowledge inconservation; biodiversity hotspots	CO4/ CO6
C	IUCN Red List categorization - guidelines, practice and application;Red Data book; ecological restoration; afforestation; social forestry;agro forestry; joint forest management; role of remote sensing in management of natural resources	CO4/ CO6
Unit 5	**Biodiversity in India**	
A	India as a mega diversity nation; phytogeographic and zoogeographic zones of the country	CO5/ CO6
B	Forest types and forest cover in India; fish and fisheries of India; impact of hydropower development on biological diversity	CO5/ CO6
C	Status of protected areas and biosphere reserves in the country;National Biodiversity Action Plan	CO5/ CO6
Mode of examination	20 marks for Test / Quiz / Assignment / Seminar. 05 marks for Class Interaction	
Weightage	CA MSE ESE	

Distribution	15	10	75
Text book/s*	1. Gaston, K J. & Spicer, J.I. 1998. Biodiversity: An Introduction. Blackwell Science, London, UK. 2. Krishnamurthy, K.V. 2004. An Advanced Text Book of Biodiversity - Principles and Practices. Oxford and IBH PublicationsCo. Pvt. Ltd. New Delhi. 3.Primack, R.B. 2002. Essentials of Conservation Biology (3rd edition). Sinauer Associates, Sunderland, USA.		

Course Articulation Matrix

Cos	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3
CO1	3	3	2	1	2	1	1	3	3	2	2	3	1	
CO2	3	3	2	1	2	1	1	3	3	2	2	3	1	
CO3	3	3	2	1	2	1	1	3	3	2	2	3	1	
CO4	3	3	2	1	2	1	1	3	3	2	2	3	1	
CO5	3	3	2	1	2	1	1	3	3	2	2	3	1	
CO6	3	3	2	1	2	1	1	3	3	2	2	3	1	

1-Slight (Low)   **2-Moderate (Medium)**   **3-Substantial (High)**

Mathematical Expectations & Probability Distributions

School: SSBSR	**Batch: 2023-27**	
Programme: B.Sc.	**Academic Year: 2023-24**	
Branch: Environmental Sciences	**Semester: II**	
1	Course Code	**CMS132**
2	Course Title	**Mathematical Expectations & Probability Distributions**
3	Credits	3
4	Contact Hours (L-T-P)	3-0-0
	Course Status	OPE
5	Course Objective	Uncertainty is ubiquitous and probability theory provides a rational description of uncertainty. There is a growing realization that randomness is an essential component in the modeling and analysis of a variety of systems. Probability has become an important conceptual framework of computer science, engineering, and physical and biological sciences. Several problems in computer engineering and other disciplines arise, which require probabilistic modeling. The complete specification of the model enquires statistical tools for the analysis of data and inference
6	Course Outcomes	CO1: Describe the basic concepts of probability and randomness with their applications. (K2, K5). CO2: Describe the properties of discrete and continuous random variables. (K2). CO3: Calculate the measures of central tendency and dispersion of data and describe the method used for analysis, including a discussion of advantages, disadvantages, and necessary assumptions. (K2, K3) CO4: Calculate and interpret the probability distributions and their applications in real life; and limit theorems. (K2,K3). CO5: Monte Carlo simulation of simple probability models, entropy, and mutual information. (K2, K5) CO6: Develop the skills to interpret the results of statistical analysis. (K2, K5).
7	Course Description	This is an introductory course in probability. Axioms of probability, conditional probability and independence, Bayes theorem, and probability distributions.

8	**Outline syllabus**		**CO Mapping**
	Unit 1	**Mathematical Expectation**	
	A	Axioms of probability, conditional probability and independence, Bayes theorem,	CO1
	B	Random variables: discrete and continuous random variables, probability mass function (p.m.f), probability density function (p.d.f) and cumulative distribution function (c.d.f), Illustrations and properties of random variables.	CO1
	C	Mathematical Expectation: Expectation of single and bivariate random variables, properties of expectation, conditional expectation, and its properties. Moments and cumulants. Moment generating function, probability generating function.	CO1
	Unit 2	**Discrete Random Variable**	
	A	Random variables, distribution function, discrete random variable, expectation, variance	CO2
	B	Discrete distributions: Bernoulli and Binomial random variable, Poisson random variable, demerits	CO2
	C	Negative binomial random variable, Geometric random variable, and their properties, merits, and demerits	CO2

Unit 3	**Continuous Random Variable**	
A	Continuous random variable: the expectation of random variable, variance	CO3
B	Continuous distributions: Uniform, Normal, Exponential, Gamma, and Cauchy, computing probabilities by conditioning, moment generating function, their properties, merits, and demerits.	CO3
C	Markov inequality and Chebyshev's inequality.	CO3
Unit 4	**Jointly Distributed Random Variables**	CO4
A	Jointly distributed random variables, Independent random variable, the sum of independent random variable	CO4, CO5
B	Central Limit Theorem, conditional distribution with example.	CO4, CO5
C	Joint probability distribution, covariance, correlation coefficient.	
Unit 5	**Generation of Random Numbers**	
A	Generation of random numbers and elements of Monte Carlo simulation.	CO5, CO6
B	Elements of information theory: entropy as a measure of randomness.	CO5, CO6
C	Exploratory data analysis, types of data, frequency tables, descriptive measures, variability measures	CO6
Mode of examination	Theory	
Weightage Distribution	CA: 15; MSE: 10; ESE:75	
Text book/s*	1. Gupta, S.C. and Kapoor, V.K., "Fundamentals of Mathematical Statistics".	
Other References	2. Daniel, Wayne W., "Biostatistics": Basic Concept and Methodology for Health Science. 3. Grewal, B.S, "Higher Engineering Mathematics". 4. Rohatgi, V.K. Introduction to Probability.	

Course Articulation Matrix

Cos	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3
CO1	2	1	2	-	1	-	-	-	-	-	-	-	-	-
CO2	2	1	2	-	1	-	-	-	-	-	-	-	-	-
CO3	2	1	2	-	1	-	-	-	-	-	-	-	-	-
CO4	2	1	2	-	1	-	-	-	-	-	-	-	-	-
CO5	2	1	2	-	1	-	-	-	-	-	-	-	-	-
CO6	2	1	2	-	1	-	-	-	-	-	-	-	-	-

1-Slight (Low)   2-Moderate (Medium)   3-Substantial (High)

Water Resource Lab

Programme: B. Sc	**Current Academic Year: 2023-2024**

Branch: Environmental Sciences		**SEMESTER: II**	
1	Course Code	**BEN153**	
2	Course Title	**Water Resource Lab**	
3	Credits	1	
4	Contact Hours (L-T-P)	0-0-2	
5	Course Status	Compulsory	
6	Max. Marks	25+25+50= 100	
7	Min. Marks		
8	Course Objective	Ability to assess the irrigation practices, recession and hydrograph	
9	Course Outcomes	CO1: Understand the soil bulk density by field method CO2: Ability to prepare the table of irrigation CO3: Understand the canal seepage loss. CO4: Be familiar with the measurement of recession constant CO5: Ability to prepare the hydrograph CO6: Overall understand the irrigation and hydrograph	
10	Course Description	Approaches for assessing the soil bulk density and irrigation methods and hydrograph analysis	
11	Outline syllabus		CO Mapping
	Unit 1	**Determination of Soil Bulk Density by Field Method**	
	A	To determine the bulk density of soil.	CO1
	B and C	To plot moisture content by weight and moisture content byvolume and then determine the soil bulk density from the graph.	CO1
	Unit 2	**Irrigation Scheduling by Book Keeping Method**	
	A	To calculate irrigation frequency	CO2
	B and C	To prepare irrigation scheduling table	CO2
	Unit 3	**Measurement of Canal Seepage Loss by Ponding Method**	
	A	To get acquainted with the field-testing procedure	CO3/CO6
	B and C	To measure the canal seepage loss by ponding method	CO3/CO6

Unit 4	**Measurement of recession constant by hydrograph**	
A	To find the recession constant for interflow	CO4/CO6
B and C	To find the recession constant for surface run-off.	CO4/CO6
Unit 5	**Hydrograph Analysis**	
A	To draw the recession limb of hydrograph on a semi-log paper	CO5/CO6
B and C	To find the recession constant for base flow.	CO5/CO6
Mode of examination	20 marks for Test / Quiz / Assignment / Seminar.05 marks for Class Interaction	
Weightage Distribution	CA	CE	ESE	
	25	25	50	
Text book/s*	1.David Keith Todd, Groundwater Hydrology, John Wiley publishers, 2004 Jacob and Bear, Hydraulics of Groundwater, McGraw Hill, 1997	

Course Articulation Matrix

Cos	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3
CO1	3	3	2	1	3	1	1	3	3	2	2	2	1	
CO2	3	3	2	1	3	1	1	3	3	2	2	2	1	
CO3	3	3	2	1	3	1	1	3	3	2	2	2	1	
CO4	3	3	2	1	3	1	1	3	3	2	2	2	1	
CO5	3	3	2	1	3	1	1	3	3	2	2	2	1	
CO6	3	3	2	1	3	1	1	3	3	2	2	2	1	

1-Slight (Low)   **2-Moderate (Medium)**   **3-Substantial (High)**

Biodiversity and Conservation Lab

School: SSBSR	Batch: 2023-2027	
Programme: B.Sc.	**Current Academic Year: 2023-2024**	
Branch: Environment alSciences	**SEMESTER: II**	
1	Course Code	**BEN156**
2	Course Title	**Biodiversity and Conversation Lab**
3	Credits	1
4	Contact Hours (L-T-P)	0-0-2
4	Course Status	Compulsory
5	Max. Marks	25+25+50 = 100
6	Min. Marks	
7	Course Objective	It helps students to understand and appreciate various concepts and issues concerning biodiversity and conservation at local, regional and global levels.
8	Course Outcomes	CO1: Describes Endemic, exotic and endangered species of India. CO2: Identify plant species of nearby area and protected areas of Uttar PradeshCO3: Knowledge of Biogeographical zones and Biosphere reserves of India CO4: List ex situ conservation sites present in India CO5: Identify National Parks of India. CO6: Knowledge about biodiversity and conservation strategies for sustainabledevelopment
9	Course Description	The course will attempt at encouraging students to appreciate the paradigm "thinkglobally, act locally" for a sustainable common future of humankind.
10	Outline syllabus		CO Mapping

	Unit 1	**Endemic and Exotic Species**	
	A	Prepare a document of endemic and exotic species of plants andanimals for a selected Protected Area Network	CO1
	B	Indicate distribution range of a plant and animal species identified asendangered on an Indian map	CO1
	Unit 2	**Identification and Description of Plant**	
	A	Identification and description of plant species of nearby area	CO2
	B and C	Prepare a map of Uttar Pradesh showing Protected Area Network(PAN) in it.	CO2

Unit 3	Bio-geographical Zones	
A	Prepare a map of India, showing bio-geographical zones	CO3/CO6
B and C	To plot biosphere reserve on a map of India.	CO3/CO6
Unit 4	Ex-situ & in-situ Conservation Sites	
A	Prepare a document of ex situ conservation sites present in India	CO4/CO6
B and C	Prepare a document of in situ conservation sites present in India	CO4/CO6
Unit 5	Plotting of National Parks	
A	To plot National Parks in every state on a map of India.	CO5/CO6
B and C	To determine floristic analysis by quadrat method	CO5/CO6
Mode of examination	20 marks for Test / Quiz / Assignment / Seminar.05 marks for Class Interaction	
Weightage Distribution	CA	CE	ESE	
	25	25	50	
Text book/s*	Krishnamurthy, K.V. 2004. An Advanced Text Book of Biodiversity - Principles and Practices. Oxford and IBH PublicationsCo. Pvt. Ltd. New Delhi.	

Course Articulation Matrix

Cos	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3
CO1	3	3	2	1	3	1	1	3	3	2	2	2	1	-
CO2	3	3	2	1	3	1	1	3	3	2	2	2	1	-
CO3	3	3	2	1	3	1	1	3	3	2	2	2	1	-
CO4	3	3	2	1	3	1	1	3	3	2	2	2	1	-
CO5	3	3	2	1	3	1	1	3	3	2	2	2	1	-
CO6	3	3	2	1	3	1	1	3	3	2	2	2	1	-

1-Slight (Low)   2-Moderate (Medium)   3-Substantial (High)

Environmental data presentation: Step forward from laboratory to industry-II

School: SSBSR	**Batch: 2023-2027**	
Programme: B.Sc.	**Current Academic Year: 2023-2024**	
Branch: Environmental Sciences	**SEMESTER: II**	
1	Course Code	**VOE102**
2	Course Title	**Environmental data presentation: Step forward from laboratory to industry-II**
3	Credits	3
4	Contact Hours (L-T-P)	0-0-6
5	Course Status	Compulsory
6	Max. Marks	25+25+50 = 100
7	Min. Marks	
8	Course Objective	Students will have the knowledge and skills to understand scientific inquiry in the performance, design, interpretation and documentation of laboratory experiments, at a level suitable to succeed at an entry-levelposition in the industry.
9	Course Outcomes	**CO1:** Describe the waste generation and methods of waste treatment for Food processing Industry. **CO2:** Describe the waste generation and methods of waste treatment for Apparel Industry. **CO3:** Analyze observations and tabulate ETP for Material processing Industry **CO4:** Identify the waste generation and treatment methods for Pesticide and Fertilizer Industry. **CO5:** Develop the knowledge about methods for Wastewater treatment of Thermal Power plant. **CO6:** Understand the need of good lab practices and finally apply the laboratory skills in research and industry
10	Course Description	This course provides students full knowledge about the Environment issue and resolving the environmental problem and understand the importance of Environmental and what are the what are the impact of human health of Environment pollution
11	Outline syllabus		CO Mapping
	Unit 1	**Introduction to Effluent Treatment Plant or ETP for Food ProcessingIndustry**	

	A	To study waste generation from food industry and its characteristics	CO1
	B & C	Most effective solution for effluent/wastewater treatment in food industry	CO1
Unit 2		**Introduction to Effluent Treatment Plant or ETP for Apparel Industry**	
	A	To study waste generation from apparel industry and its characteristics	CO2
	B & C	Most effective solution for effluent/wastewater treatment in apparel industry	CO2
Unit 3		**Introduction to Effluent Treatment Plant or ETP for MaterialProcessing Industry**	
	A	To study waste generation from material processing industry and its characteristics	CO3
	B & C	Most effective solution for effluent/wastewater treatment in material processing industry	CO3
Unit 4		**Introduction to Effluent Treatment Plant or ETP for Pesticide andfertilizer Industry**	
	A	To study waste generation from Pesticide and fertilizer industry and its characteristics	CO4
	B & C	Most effective solution for effluent/wastewater treatment in Pesticide andfertilizer industry	CO4
Unit 5		**Introduction to Effluent Treatment Plant or ETP for Thermal Powerplants**	
	A	To study waste generation from thermal power plants and its characteristics	CO5, CO6
	B & C	Most effective solution for effluent/wastewater treatment in Thermal power plants	CO5, CO6
Mode of examination		20 marks for Test / Quiz / Assignment / Seminar.05 marks for Class Interaction	

Weightage Distribution	CA	CE	ESE	
	25	25	75	

Text book/s*	Industrial & Hazardous waste treatment by Nelson L. Nemerow and Avijit Dasgupta Industrial Pollution Preventive Handbook by Freeman Industrial water pollution control by W. Wesley Echenfelder,	
Suggestive Digital Platforms / Web Links	1. https://www.researchgate.net/publication/268049349_ Development_of_a_Standardized_Procedure_for_Cleaning_Gl ass_Apparatus_in_Analytical_Laboratories 2. https://www.vlab.co.in/broad-area-chemical-sciences http://chemcollective.org/vlabs	

Cos	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3
CO1	3	3	2	1	3	1	1	3	3	2	2	2	1	-
CO2	3	3	2	1	3	1	1	3	3	2	2	2	1	-
CO3	3	3	2	1	3	1	1	3	3	2	2	2	1	-
CO4	3	3	2	1	3	1	1	3	3	2	2	2	1	-
CO5	3	3	2	1	3	1	1	3	3	2	2	2	1	-
CO6	3	3	2	1	3	1	1	3	3	2	2	2	1	-

Slight (Low)   **2-Moderate (Medium)**   **3-Substantial (High)**

School:SSBSR	**Batch 2023-2027**	
	Current Academic year 2023-24	
	Semester II	
Course Code	**ARP102**	
Course Title	Communicative English -2	
Credits	2	
Contact Hours (L-T-P)	0-1-2	
Course Objective	To Develop LSRW skills through audio-visual language acquirement, creative writing, advanced speech et al and MTI Reduction with the aid of certain tools like texts, movies, long and short essays.	
Course Outcomes	After completion of this course, students will be able to: CO1 Acquire Vision, Goals and Strategies through Audio-visual Language Texts CO2 Synthesize complex concepts and present them in creative writing CO3 Develop MTI Reduction/Neutral Accent through Classroom Sessions & Practice CO4 Determine their role in achieving team success through defining strategies for effective communication with different people CO5 Realize their potentials as human beings and conduct themselves properly in the ways of world. CO6 Acquire satisfactory competency in use of Quantitative aptitude and Logical Reasoning	
Course Description	The course takes the learnings from the previous semester to an advanced level of language learning and self-comprehension through the introduction of audio-visual aids as language enablers. It also leads learners to an advanced level of writing, reading, listening and speaking abilities, while also reducing the usage of L1 to minimal in order to increase the employability chances.	
Outline syllabus – ARP 102		CO Mapping
Unit A	**Acquiring Vision, Goals and Strategies through Audio-visual Language Texts**	
Topic 1	Pursuit of Happiness / Goal Setting & Value Proposition in life	CO1
Topic 2	12 Angry Men / Ethics & Principles	
Topic 3	The King's Speech / Mission statement in life | strategies & Action Plans in Life	
Unit B	**Creative Writing**	
Topic 1	Story Reconstruction - Positive Thinking	CO2
Topic 2	Theme based Story Writing - Positive attitude	
Topic 3	Learning Diary Learning Log – Self-introspection	
Unit C	**Writing Skills 1**	
Topic 1	Precis	CO2
Topic 2	Paraphrasing	
Topic 3	Essays (Simple essays)	

Unit D	**MTI Reduction/Neutral Accent through Classroom Sessions & Practice**	
Topic 1	Vowel, Consonant, sound correction, speech sounds, Monothongs, Dipthongs and Tripthongs	CO3
Topic 2	Vowel Sound drills , Consonant Sound drills, Affricates and Fricative Sounds	
Topic 3	Speech Sounds	Speech Music| Tone	Volume| Diction |Syntax |Intonation	Syllable Stress		
Unit E	**Gauging MTI Reduction Effectiveness through Free Speech**	
Topic 1	Jam sessions	CO3
Topic 2	Extempore	
Topic 3	Situation-based Role Play	
Unit F	**Leadership and Management Skills**	
Topic 1	Innovative Leadership and Design Thinking	CO4
Topic 2	Ethics and Integrity	CO4
Unit F	**Universal Human Values**	
Topic 1	Love & Compassion, Non-Violence & Truth	CO5
Topic 2	Righteousness, Peace	CO5
Topic 3	Service, Renunciation (Sacrifice)	CO5
Unit G	**Introduction to Quantitative aptitude & Logical Reasoning**	
Topic 1	Analytical Reasoning & Puzzle Solving	CO6
Topic 2	Number Systems and its Application in Solving Problems	CO6
Evaluations	*Class Assignments/Free Speech Exercises / JAM Group Presentations/Problem Solving Scenarios/GD/Simulations (60% CA and 40% ESE*	
Texts & References	Library Links	• Wren, P.C.&Martin H. *High English Grammar and Composition*, S.Chand& Company Ltd, New Delhi. • Blum, M. Rosen. *How to Build Better Vocabulary*. London: Bloomsbury Publication • Comfort, Jeremy(et.al). *Speaking Effectively*. Cambridge University Press. The Luncheon by W.Somerset Maugham - http://mistera.co.nf/files/sm_luncheon.pdf	•

Course Articulation Matrix

Cos	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3
CO1	2	2	1	3	-	-	-	-	-	-	-	-	-	-
CO2	2	2	1	3	-	-	-	-	-	-	-	-	-	-
CO3	2	2	1	3	-	-	-	-	-	-	-	-	-	-
CO4	2	2	1	3	-	-	-	-	-	-	-	-	-	-
CO5	2	2	1	3	-	-	-	-	-	-	-	-	-	-
CO6	2	2	1	3	-	-	-	-	-	-	-	-	-	-

1-Slight (Low)   **2-Moderate (Medium)**   **3-Substantial (High)**

Yoga for Holistic health

School: SSBSR	Batch: 2023-2027	
Programme: B.Sc.	Current Academic Year: 2023-2024	
Branch: Environmental Sciences	SEMESTER: II	
1	Course code	VAC110
2	Course Title	Yoga for Holistic health
3	Credits	3
4	Learning Hours	0-1-4
5	Course Objective	To make the students familiar with the different practices of yoga, chanting and meditation techniques and learn the correct teaching skills.
6	Course Outcomes	1. To make the students understand the concept of health and wellness through Yoga 2. To define the concept and principles of Yoga. 3. To interpret and understand the breathing practice. 4. To describe the knowledge about Yoga, its foundations and applications to the aspirants. 5. To make students aware of Yogic impact on the positive health and personality development. 6. The students will learn primary level of Yoga practices, which will groom their personality.
7	Outline syllabus:		CO mapping
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7.1		Unit A	**Importance of Health, Wellness through Yoga**	
7.11		Topic 1	Meaning, Definition, Aim of Yoga; Concept of health according to WHO and Ayurveda	CO1, CO2, CO4, CO5, CO6
7.12		Topic 2	Misconception about Yoga, Difference between asana and physical exercise	CO1, CO2, CO4, CO5, CO6
7.13		Topic 3	Need, Importance of Yoga in health and wellness	CO1, CO2, CO4, CO5, CO6
7.2		**Unit B**	**Schools of Yoga, Modern and Ancient schools of Yoga existing in India, Yogic diet, Yogic attitudes, Sadhak tatva & Badhak tatva**	
7.21		Topic 1	Schools/ Streams of Yoga – Ashtanga Yoga, Bhakti Yoga, Karma Yoga, Jnana Yoga	CO3, CO4, CO5, CO6
7.22		Topic 2	Modern and ancient schools of Yoga existing in India – Natha Sampradaya, Kaivalyadhama, Bihar School of Yoga, Munger, Pragya Yoga (Shantikunj), Iyengar Yoga, Patanjali Yoga Peeth, Ashtanga Vinyasa Yoga	CO3, CO4, CO5, CO6

7.23		Unit B Topic 3	Yoga Ahaara (Yogic diet), Yogic Attitudes – Maitri Karuna, Mudita, Upeksha, Sadhak Tatva Badhak Tatva (facilitating/helping factors and obstacles in Yoga sadhana)	CO3, CO4, CO5, CO6
7.3		**Unit C**	**Beginner level practices – Sukshma Vyayama and Surya Namaskara**	
7.31		Unit C Topic 1	Sukshma Vyayama and their benefits for health Part-1 (Bihar School of Yoga) Part-1	CO4, CO5, CO6
7.32		Unit C Topic 2	Sukshma Vyayama & their benefits for health (Swami Dhirendra Brahmachari) Part-1	CO4, CO5, CO6
7.33		Unit C Topic 3	Surya Namaskara (Sun Salutation) with mantra chanting (12 steps) & their benefits for health	CO4, CO5, CO6
7.4		**Unit D**	**Asana - all categories**	
7.41		Unit D Topic 1	Standing & Sitting - Tadasana, Vrikshasana, Katichakrasana, Padmasana, Vajrasana, Ushtrasana, Paschimottanasana, Vakrasana	CO4, CO5, CO6
7.42		Unit D Topic 2	Supine and Prone: Uttanapadasana, Pawanamuktasana, Shalabhasana, Bhujangasana	CO4, CO5, CO6
7.43		Unit D Topic 3	Balancing and Inverted: Trivikramasana, Sarvangasana, Viparitakarani mudra	CO4, CO5, CO6
7.5		Unit E	Pre-practices of Pranayama, Pranayama and Dhyana	
7.51		Unit E Topic 1	Kapalabhati, Mukha dhauti, Vibhagiya pranayama (Sectional breathing)	CO1, CO4, CO5, CO6
7.52		Unit E Topic 2	Anuloma – Viloma, Bhastrika, Shitali	CO1, CO4, CO5, CO6
7.53		Unit E Topic 3	Om Dhyana, Aanapaanasati Dhyana (breath meditation)	CO1, CO4, CO5, CO6
8	**Course Evaluation**			
8.1	Course work:			
8.11	Attendance			
8.12	Homework	Three best out of five assignments: 10 marks		
8.13	Quizzes	Three best out of five tests: 10 marks		
8.14	Projects	None		
8.15	Presentations	One best out of two: 10 marks		
8.2	CA: 60 % Practical			

8.3	End-term examination: 40% Viva	
9	**References**	
9.1	Text book	1. Sri Ananda: The Complete book of Yoga, Orient Course Backs, Delhi, 2003. 2. Basavaraddi, I.V. & other: SHATKARMA: A Comprehensivedescription about Cleansing Process, MDNIY New Delhi, 2009 3. Joshi, K.S.: Yogic Pranayama, Oriental Paperback, New Delhi, 2009 4. Dr. Nagendra H R: Pranayama, The Art & Science, Swami Vivekananda Yoga Prakashan, Bangalore, 2005. 5. Swami Niranjanananda Saraswati: Asana Pranayama Mudra Bandha, Yoga Publication Trust, Munger Bihar. 6. Joshi, K.S.: Yogic Pranayama, Oriental Paperback, New Delhi, 2009 7. Swami Kuvalyananda: Pranayama, Kaivalyadhama, Lonavla, 2010 8. Swami Rama: Science of Breath, A Practical Guide, The Himalayan International Institute, Pennselvenia, 1998. 9. Swami Niranjanananda Saraswati: Prana, Pranayama & Pranavidya, Yoga Publications Trust, Munger, Bihar, 2005

Course Articulation Matrix

Cos	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3
CO1			2			1	1		2	2	1			
CO2			2			1	1		2	2	1			
CO3			2			1	1		2	2	1			
CO4			2			1	1		2	2	1			
CO5			2			1	1		2	2	1			
CO6			2			1	1		2	2	1			

1-Slight (Low)   **2-Moderate (Medium)**   **3-Substantial (High)**

Second Year
Detailed syllabus for
Diploma
In
Environmental Sciences

School: SSBSR	Batch: 2023-2027	
Programme: B.Sc.	Current Academic Year: 2024-2025	
Branch: Environmen talSciences	SEMESTER: III	
1	Course Code	BEN201
2	Course Title	ATMOSPHERIC AND GLOBAL CLIMATE CHANGE
3	Credits	4
4	Contact Hours(L-T-P)	4-0-0
5	Course Status	Compulsory
6.	Max Marks	15+10+75=100
7.	Min Marks	
8.	Course Objective	Understand issues related to the Environment Acquire basic understanding of another component of environmentUnderstand issues related to the Atmosphere
9.	Course Outcomes	After studying this course, students will be able to CO1: To define and Understand issues related to the Environment CO2: Explain the Acquire basic understanding of another component of environmentCO3: To identify and Understand issues related to the Atmosphere CO4: Analysis the issues related to the Environment and climate changeCO5: Define the principles of Climate change CO6: design and develop the Prepare for information processing and statistical analysisglobal warming ang climate change
10.	Course Description	The successful graduate will be prepared for entry-level positions within a wide range ofhealth care area including:

11	Outline syllabus		CO Mapping
	Unit 1	**Global Energy Balance**	
	A	Earth's energy balance;	CO1
	B	energy transfers in atmosphere; Earth's radiation budget; greenhouse gases	CO1
	C	(GHGs); greenhouse effect; global conveyor belt.	CO1
	Unit 2	**Atmospheric Circulation**	
	A	Movement of air masses; atmosphere and climate; air and sea interaction;southern oscillation; western disturbances; EI Nina and La Nina;	CO2
	B	tropical cyclone; Indian monsoon and its development,	CO2
	C	effect of urbanization on micro climate; Asian brown clouds	CO2
	Unit 3	**Meteorology and Atmospheric Stability**	
	A	Meteorological parameters (temperature, relative humidity, wind speed anddirection, precipitation);	CO3/CO6
	B	atmospheric stability and mixing heights; temperature inversion;	CO3/CO6
	C	plume behavior; Gaussian plume model	CO3/CO6
	Unit 4	**Climate Change and Its Impact**	

	A	Earth's climate through ages; trends of global warming and climate change; drivers of global warming and the potential of different green-house gases (GHGs) causing the climate change;	CO4/CO6
	B	impact of climate change on atmosphere, weather patterns, sea level rise,agricultural productivity and biological responses - range shift of species	CO4/CO6
	C	International agreements; Kyoto protocol 1997; Convention on Climate Change; carbon credit and carbon trading; clean development mechanism.	CO4/CO6
Unit 5		**Ozone Layer Depletion**	
	A	Ozone layer or ozone shield; importance of ozone layer; ozone layer depletionand causes; Chapman cycle	CO5/CO6
	B	process of spring time ozone depletion over Antarctica; ozone depleting substances (ODS); effects of ozone depletion;	CO5/CO6
	C	mitigation measures and international protocols - Montreal protocol 1987.	CO5/CO6
Mode of examination		Theory	
Weightage Distribution		CA	MSE	ESE	
		15	10	75	
Text book/s*		The Nature, Causes, Effects and Mitigation of Climate Change on the Environment (pp.1-16) Chapter: Global Warming and Climate Change (GWCC) RealitiesPublisher: Intech Open Limited	
Other References		GLOBAL WARMING AND CLIMATE CHANGE (GWCC) REALITIES	

Course Articulation Matrix

Cos	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3
CO1	3	3	2	1	3	1	1	3	3	2	2	1	3	-
CO2	3	3	2	1	3	1	1	3	3	2	2	1	3	-
CO3	3	3	2	1	3	1	1	3	3	2	2	1	3	-
CO4	3	3	2	1	3	1	1	3	3	2	2	1	3	-
CO5	3	3	2	1	3	1	1	3	3	2	2	1	3	-
CO6	3	3	2	1	3	1	1	3	3	2	2	2	3	-

1-Slight (Low)   **2-Moderate (Medium)**   **3-Substantial (High)**

Analytical Techniques

School: SSBSR	**Batch: 2023-2027**	
Programme: B.Sc.	**Current Academic Year: 2024-2025**	
Branch: Environmental Sciences	**SEMESTER: III**	
1	Course Code	**BEN202**
2	Course Title	**Analytical Techniques**
3	Credits	3
4	Contact Hours (L-T-P)	3-0-0
5	Course Status	Compulsory
6	Course Objective	1. A brief about evaluation of the analytical data would be given along with an introduction to the concepts of errors, accuracy, precision and significant figures. 2. The unit ends with the ways of reporting the results of analysis.
7	Course Outcomes	After studying this course, students will be able to CO1: To define and Understand The environmental scientists are generally concerned with the identification, characterization and quantification of materials present in the environment, both polluting and non-polluting. In other words, we can say that the important task for an environmental analyst in this context is finding out what and how much of the materials present in the environment. CO2: Explain the Acquire basic understanding in brief the principals involved in the analytical techniques. CO3: To identify and understand the procedure of sampling of environmental materials, CO4: To analyze and understand method of measurement during environmental analysis, materials CO5: To Define and Understand principles concept of errors, accuracy, precision and significant figures. CO6: Develop the and prepare for information processing and statistical analysis of differentiate between accuracy and precision
8	Course Description	The environmental scientists are generally concerned with the identification, characterization and quantification of materials present in the environment, both polluting and non-polluting. In other words, we can say that the important task for an environmental analyst in this context is finding out what and how much of the materials present in the environment.

9	Outline syllabus		CO Mapping
	Unit 1	**Principles and application of Spectrophotometry**	
	A	(UV-Visible spectrophotometry),	CO1
	B	Titrimetric, Gravimetry, Colorimetry, NMR	CO1
	C	Microscopy-phase, light and fluorescence microscopes, Scanning and Transmission electron microscopes.	CO1
	Unit 2	**Chromatographic techniques**	

A	Column chromatography, Atomic absorption spectrophotometry	CO2
B	Fixation and staining, Principles and techniques of nucleic acid hybridization and Cot curves,	CO2
C	Principle of biophysical method used for analysis of biopolymer structure, Hydrodynamics methods, Plasma emission spectroscopy.	CO2
Unit 3	**X-ray techniques**	
A	Electrophoresis, solid and liquid scintillation, X-ray florescence,	CO3/CO6
B	X-ray diffraction. Flame photometry, Gas-liquid chromatography,	CO3/CO6
C	High pressure liquid chromatography - auto radiography, Ultracentrifugation.	CO3/CO6
Unit 4	**Methods for measuring**	
A	nucleic acid and protein interactions,	CO4/CO6
B	DNA finger printing	CO4/CO6
C	Molecular markers RFLP	CO4/CO6
Unit 5	**Techniques**	
A	AFLP, RAPD,	CO5/CO6
B	Sequencing of proteins and nucleic acids, southern, northern, western blotting techniques,	CO5/CO6
C	PCR polymerase chain reaction.	CO5/CO6
Mode of examination	Theory	
Weightage Distribution	CA	MSE	ESE	
	15	10	75	
Text book/s*	Principles of Biophysical chemistry - Uppadahay -Uppadahay- and Nath	
Other References	2. Analytical Techniques - S.K. Sahani	

Course Articulation Matrix

Cos	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3
CO1	3	3	2	1	2	2	3	2	2	2	1	2	3	2
CO2	2	3	3	3	1	1	3	2	2	2	2	1	3	1
CO3	3	3	2	1	1	2	3	2	2	1	1	2	3	1
CO4	3	2	2	2	1	1	3	2	2	2	1	1	3	1
CO5	3	3	1	1	1	2	3	2	2	2	1	2	3	1
CO6	3	3	2	1	1	2	3	2	2	1	2	2	3	1

1-Slight (Low)   **2-Moderate (Medium)**   **3-Substantial (High)**

Environment Microbiology

	School: SSBSR	Batch: 2023-2027	
	Programme: B.Sc.	Current Academic Year: 2024-2025	
	Branch: Environmental Sciences	SEMESTER: III	
1	Course Code	BEN203	
2	Course Title	**Environment Microbiology**	
3	Credits	3	
4	Contact Hours (L-T-P)	3-0-0	
5	Course Status	Minor / Elective	
6	Course Objective	1 Diversity of Microbial habitat 2 Microbial interactions 3 Microbiology of air, soil and water 4 Microbiology of waste water and effluent treatments	
7	Course Outcomes	After studying this course, students will be able to CO1: TO define the Basic concepts, types and microbial habitats, factors affectingmicrobial population. CO2: Explain the Microbial interactions: competition, commensalism CO3: To define the diversity, characteristic features and significance of eubacteria CO4: Analysis and characteristics of population, population growth curves (r and kselection) population regulation CO5: Define the microbial degradation of xenobiotics, petroleum and oil spills inenvironmental decay behaviors and degradative plasmid. CO6: To Apply the physiology, morphology, biochemistry of microbial biofilms.	
8	Course Description	The course comprises of general and basic features of microbial ecology, microbiologyof air, water and soil. This also focused on microbiology and its use in effluent treatment.	
9	Outline syllabus		CO Mapping
	Unit 1	**Microbial Ecology**	
	A	Basic concepts, types and microbial habitats, factors affecting microbialpopulation.	CO1
	B	Microbial interactions: competition, commensalism, parasitism, mutualism,commensalisms, synergism.	CO1
	C	Population ecology: characteristics of population, population growth curves (r and k selection) population regulation.	CO1
	Unit 2	**Microbiology of Air**	
	A	Microbiology of air: microorganism of air, enumeration of air micro flora.Significance of air micro flora.	CO2
	B	Brief account of air borne transmission of bacteria, fungi, pollens and viruses.	CO2
	C	Airborne diseases and their prevention.	CO2

Unit 3	**Soil Microbiology**			
A	Microflora of soil: soil microorganisms associated with plants: rhizosphere, mycorrhizae.	CO3/CO6
B	Role of microorganisms in organic matter decomposition (cellulose, hemi cellulose, lignin).	CO3/CO6
C	Bioleaching; introduction, application of bacterial leaching techniques,properties of bioleaching.	CO3/CO6
Unit 4	**Water Microbiology**	
A	Aquatic microorganisms; fresh water and sea water microflora,Microorganisms and water quality, water pollution	CO4/CO6
B	Water purity test and indicator organisms, method used in environmentalstudies –BOD, COD, DO.	CO4/CO6
C	Common water born disease and their control measure. Water purification:flocculation, chlorination and purification.	CO4/CO6
Unit 5	**Microbiology of waste water and effluent treatments**	
A	Aerobic process: primary, secondary and tertiary treatment: trickle filter,oxidation ponds and stabilization ponds, principle of aerobic digestion.	CO5/CO6
B	Bioremediation of contaminations. Extremophiles –acidophilic, alkalophilic,thermophilic microbes and application in ecosystem.	CO5/CO6
C	Microbial biofilms: physiology, morphology, biochemistry of microbial biofilms, beneficial and harmful role of biofilms	CO5/CO6
Mode of examination	Theory	
Weightage Distribution	CA	MSE	ESE	
	15	10	75	
Text book/s*	1. Microbial Ecology: Fundamentals and applications, Ronals M, Atlas,fourth edition, Animprint of Addison Wesley Longman. Inc, California 2. Environmental chemistry, A.K. De, Wiley Eastern Ltd., New Delhi	
Other References	1. Environmental Science, Physical Principles and applications; EgbertBoeker et. al. 2. Comprehensive Biotechnology, vol.4, M.moo-young (Ed-in-chief), Pergmon Press, Oxford. 3. Wastewater Treatment for Pollution Control By Soli J Arceivala, SecondEdition, Tata McGraw- Hill Publishing Company Limited. 4. Environmental Biotechnology Theory and Application by Gareth M. Evansand Judith C. Furlong, John Wiley and Sons, LTD, U.S.A. 5. Ecology and Environment by P.D. Sharma, Rastogi Publications, NewDelhi, India	

Course Articulation Matrix

Cos	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3
CO1	3	3	2	1	2	2	3	2	2	2	1	2	3	-
CO2	2	3	3	3	1	1	3	2	2	2	2	1	3	-
CO3	3	3	2	1	1	2	3	2	2	1	1	2	3	-
CO4	3	2	2	2	1	1	3	2	2	2	1	1	3	-
CO5	3	3	1	1	1	2	3	2	2	2	1	2	3	-
CO6	3	3	2	1	1	2	3	2	2	1	2	2	3	-

1-Slight (Low)   2-Moderate (Medium)   3-Substantial (High)

Data Preparation and Data Cleaning

School: SSBSR	**Batch: 2023-27**	
Programme: B.Sc.	**Academic Year: 2024-25**	
Branch: Environmental Sciences	**Semester: III**	
1	Course Code	**BDA217**
2	Course Title	**Data Preparation and Data Cleaning**
3	Credits	3
4	Contact Hours (L-T-P)	3-0-0
	Course Status	Minor / Elective
5	Course Objective	To make students familiar with the concepts of preparing your data; Working with dates and times, Data Cleaning, Data Structure, and cleaning Text Data.
6	Course Outcomes	CO1: Describe preparing data: Rearranging and removing variables, renaming variables, Variable classes, calculating new numeric variables, and explaining how to Dividing a continuous variable into categories, and working with factor variables. (K1, K3) CO2: Discuss how to work with dates and times, adding and removing observations and explain about removing duplicate observations, selecting a subset of the data, selecting a random sample from a dataset, and sorting a dataset. (K2, K3, K4) CO3: Explain the data cleaning and technical representation of data. (K2, K3, K4) CO4: Discuss the data structure. (K2, K6) CO5: Describe Character Normalization, Encoding Conversion and Unicode Normalization, Character Conversion, and Transliteration. (K1, K2) CO6: Discuss and evaluate Generating Regular Expressions in R, Common String Processing Tasks in R, Approximate Text Matching, String Metrics, String Metrics, and Approximate Text Matching in R.
7	Course Description	This course introduces preparing your data; Working with dates and times, Data Cleaning, Data Structure, and cleaning Text Data.
8			

Unit 1			
A	Preparing your data: Rearranging and removing variables, renaming variables, Variable classes, Calculating new numeric variables,		CO1
B	Dividing a continuous variable into categories, Working with factor variables,		CO1
C	Manipulating character variables: Concatenating character strings, extracting a substring, Searching a character variable.		CO1
Unit 2			
A	Working with dates and times, Adding and removing observations,		CO2
B	Removing duplicate observations, Selecting a subset of the data,		CO2
C	Selecting a random sample from a dataset, Sorting a dataset.		CO2
Unit 3			
A	Data Cleaning: The Statistical Value Chain, Raw Data, Input Data, Valid Data, Statistics, and Output.		CO3
B	Technical Representation of Data: Numeric Data, Integers, Integers in R, Real Numbers, Double Precision Numbers, The Concept of Machine Precision, Consequences of Working with Floating Point Numbers, Dealing with the		CO3

	Consequences,	
C	Numeric Data in R. Text Data. Terminology and Encodings. Unicode. Textual Data in R: Objects of Class Character. Encoding in R. Reading. and Writing of Data with Non-Local Encoding. Detecting Encoding. Collation. and Sorting. Times and Dates. Time and Date Notation. Time and Date Storage in R. Time and Date Conversion in R, Leap Days, Time Zones, and Daylight-Saving Times.	CO3C
Unit 4		
A	Data Structure: Introduction, Tabular Data, data.frame, Databases, dplyr, Matrix Data, Time Series,	CO4
B	Graph Data, Web Data, Web Scraping, Web API, Other Data, Tidying Tabular Data,	CO4
C	Variable Per Column, Single Observation Stored in Multiple Tables.	CO4
Unit 5		
A	Cleaning Text Data: Character Normalization. Encoding Conversion and Unicode Normalization, Character Conversion and Transliteration,	CO5
B	Pattern Matching with Regular. Expressions. Basic Regular Expressions, Practical Regular Expressions, Generating Regular Expressions in R,	CO5
C	Common String Processing Tasks in R. Approximate Text Matching, String Metrics, String Metrics, and Approximate Text Matching in R.	CO6
Mode of examination	Theory	
Weightage Distribution	CA: 15%; MTE: 10%; ETE: 75%	
Text book/s*	1. Bad Data Handbook: Cleaning Up the Data So You Can Get Back to Work by Q. Ethan McCallum 2. Best Practices in Data Cleaning: A Complete Guide to Everything You Need to Do Before and After Collecting Your Data by Jason W Osborne	
Other References	1. Data Wrangling with Python by Jacqueline Kazil 2. Principles of Data Wrangling: Practical Techniques for Data Preparation by Tye Rattenbury	

Course Articulation Matrix

Cos	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3
CO1	2	1	2	-	1	-	-	-	-	-	-	-	-	-
CO2	2	1	2	-	1	-	-	-	-	-	-	-	-	-
CO3	2	1	2	-	1	-	-	-	-	-	-	-	-	-
CO4	2	1	2	-	1	-	-	-	-	-	-	-	-	-
CO5	2	1	2	-	1	-	-	-	-	-	-	-	-	-
CO6	2	1	2	-	1	-	-	-	-	-	-	-	-	-

1-Slight (Low)   2-Moderate (Medium)   3-Substantial (High)

Environmental data presentation: Step forward from laboratory to industry-III

School: SSBSR	Batch: 2023-2027	
Programme: B.Sc.	Current Academic Year: 2024-2025	
Branch: Environmental Sciences	SEMESTER: III	
1	Course Code	VOE103
2	Course Title	**Environmental data presentation: Step forward from laboratory to industry-III**
3	Credits	3
4	Contact Hours (L-T-P)	0-0-6
5	Course Status	Compulsory
6	Max. Marks	25+25+50 = 100
7	Min. Marks	
8	Course Objective	Students will have the knowledge and skills to understand scientific inquiry in the performance, design, interpretation and documentation of laboratory experiments, at a level suitable to succeed at an entry-level position in the industry.
9	Course Outcomes	**CO1:** Develop the knowledge about EIA study on Building and construction project. **CO2:** Develop the knowledge about EIA study on Mining project. **CO3:** Develop the knowledge about EIA study on Thermal power plant. **CO4:** Develop the knowledge about EIA study on Hydropower project. **CO5:** Develop the knowledge about methods for EIA study of Air Transport development project. **CO6:** Understand the need of good lab practices and finally apply the laboratory skills in research and industry
10	Course Description	This course provides students full knowledge about the Environment issue and resolving the environmental problem and understand the importance of Environmental and what are the what are the impact of human health of Environment pollution
11	Outline syllabus	CO Mapping

Unit 1	**EIA Case study of Building and construction Project**	
A	Draft an EIS report on building and construction project	CO1
B & C	EIA report on case study of building and construction project	CO1
Unit 2	**EIA Case study of Mining Project**	
A	Draft a preliminary report on mining project	CO2
B & C	EIA report on case study of mining project.	CO2
Unit 3	**EIA Case study of Thermal Power Plant**	
A	Draft a report before public hearing on Thermal Power plant.	CO3, CO6
B & C	EIA report on case study of Thermal Power plant.	CO3, CO6
Unit 4	**EIA Case study of Hydropower Project**	
A	Draft a report before public hearing on Hydropower project.	CO4, CO6
B & C	EIA report on case study of Hydropower project.	CO4, CO6
Unit 5	**EIA Case study of Air Transport Development Project**	
A	Draft a preliminary report on Air Transport development project.	CO5, CO6
B & C	EIA report on case study of Air Transport development project.	CO5, CO6
Mode of examination	20 marks for Test / Quiz / Assignment / Seminar.05 marks for Class Interaction	
Weightage Distribution	CA	CE	ESE	
	25	25	75	
Text book/s*	1. Larry. W. Canter : Environmental Impact Assessment 2. Glasson T : Environmental Impact Assessment 3. Petter Morris: Environmental Impact Assessment 4. Eceleston, C.H. : Environmental Impact Statemen	
Suggestive Digital Platforms / Web Links	1. https://www.researchgate.net/publication/268049349_ Development_of_a_Standardized_Procedure_for_Cleaning_Gl ass_Apparatus_in_Analytical_Laboratories 2. https://www.vlab.co.in/broad-area-chemical-sciences http://chemcollective.org/vlabs	

Course Articulation Matrix

Cos	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3
CO1	3	3	2	1	3	1	1	3	3	2	2	2	1	1
CO2	3	3	2	1	3	1	1	3	3	2	2	2	1	1
CO3	3	3	2	1	3	1	1	3	3	2	2	2	1	1
CO4	3	3	2	1	3	1	1	3	3	2	2	2	1	1
CO5	3	3	2	1	3	1	1	3	3	2	2	2	1	1
CO6	3	3	2	1	3	1	1	3	3	2	2	2	1	1

1-Slight (Low)   **2-Moderate (Medium)**   **3-Substantial (High)**

Atmospheric and Global Climate Change Lab

School: SSBSR	**Batch: 2023-2027**	
Programme: B.Sc.	**Current Academic Year: 2024-2025**	
Branch: Environmental Science	**SEMESTER: III**	

1	Course Code	**BEN251**
2	Course Title	**ATMOSPHERIC AND GLOBAL CLIMATE CHANGE LAB**
3	Credits	1
4	Contact Hours (L-T-P)	0-0-2
5	Course Status	Compulsory
6	Course Objective	Understand issues related to the Environment Acquire a basic understanding of another component of the environment Understand issues related to the Atmosphere
7	Course Outcomes	After studying this course, students will be able to CO1: To identify and understand the working of CAQMS CO2: To acquire the basic knowledge for the determination of wind speed and wind direction. CO3: To identify and understand the basics of WR Plot CO4: Analysis of the issues related to the Environment and climate change CO5: Define the principles of Climate change CO6: To acquire an overall understanding of atmospheric science and climatic change.
8	Course Description	The successful graduate will be prepared for entry-level positions within a wide knowledge of climate and environment

9	Outline syllabus		CO Mapping
	Unit 1	**Demonstration of CAQMS (Continuous Air QualityMonitoring Station)**	
	A	Demonstration of Real-Time Monitoring Station	CO1
	B	Demonstration of Anemometer	CO1
	Unit 2	**Determination of Wind speed and Wind Direction**	
	A	Determination of Wind Speed	CO2
	B	Determination of Wind Direction	CO2
	Unit 3	**Preparation of Wind Rose Diagram**	
	A	Preparation of Wind Rose Diagram by WR Plot	CO3
	B	Export wind rose diagram to Google Earth	CO3
	Unit 4	**Case Study- Impact of Climate Change**	
	A	Impact of Climate Change on Animals	CO4/CO6
	B	Impact of Climate Change on Plants	CO4/CO6
	Unit 5	**Minor Project**	
	A	Review of Literature	CO5/CO6
	B	Drafting and Compilation of project Report	CO5/CO6
	Mode of examination	Practical	
	Weightage Distribution	CA	CE (viva)	ESE	
		25	25	50	

	Text book/s*	The Nature, Causes, Effects and Mitigation of ClimateChange on the Environment (pp.1-16) Chapter: Global Warming and Climate Change (GWCC)Realities Publisher: IntechOpen Limited	
	Other References	GLOBAL WARMING AND CLIMATE CHANGE(GWCC) REALITIES	

Course Articulation Matrix

Cos	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3
CO1	3	3	2	1	2	2	3	2	2	2	1	2	3	-
CO2	2	3	3	3	1	1	3	2	2	2	2	1	3	-
CO3	3	3	2	1	1	2	3	2	2	1	1	1	3	-
CO4	3	2	2	2	1	1	3	2	2	2	1	1	3	-
CO5	3	3	1	1	1	2	3	2	2	2	1	1	3	-
CO6	3	3	2	1	1	2	3	2	2	1	2	1	3	-

1-Slight (Low)   **2-Moderate (Medium)**   **3-Substantial (High)**

Analytical Lab I

School: SSBSR	**Batch: 2023-2027**		
Programme: B.Sc.	**Current Academic Year: 2024-2025**		
Branch: Environmental Sciences	**SEMESTER: III**		
1	Course Code	**BEN252**	
2	Course Title	**Analytical Lab I**	
3	Credits	1	
4	Contact Hours (L-T-P)	0-0-2	
4	Course Status	Compulsory	
5	Max. Marks	25+25+50 = 100	
6	Min. Marks		
7	Course Objective	To determine physical and chemical properties of water.	
8	Course Outcomes	CO1: Preparation of solutions in varying concentrations. CO2: Determination of pH and conductivity of water samples. CO3: Determination of dissolved nutrients from water samples. CO4: Estimation of Sulphates from water sample. CO5: Determination of alkalinity, carbonate and bicarbonate from water sample. CO6: Determination of physical and chemical properties of water.	
9	Course Description	To determine physical and chemical properties of water.	
10	Outline syllabus		CO Mapping
	Unit 1	**Molar and Moral Solution**	
	A	Preparation of Normal, Molar and Molar solutions.	CO1
	B and C	Preparation of ppm and percentage solutions.	CO1
	Unit 2	**pH & Conductivity**	
	A	Determine the pH of given water sample.	CO2

B and C	Determine the conductivity of given water sample.	CO2
Unit 3	**Nutrient Phosphates & Nitrates**	
A	Predict the presence of dissolved nutrient phosphates in a sample of water	CO3/CO6
B and C	Predict the presence of dissolved nutrient nitrates in a sample of water.	CO3/CO6
Unit 4	**Estimation of Sulphates & Nitrate**	
A	Estimation of sulphates in water samples.	CO4/CO6
B and C	Estimation of nitrate in water samples.	
Unit 5	**Alkalinity**	
A	Determine the alkalinity of given water sample.	CO5/CO6
B and C	Test the presence of carbonates and bicarbonates in the sample of water.	CO5/CO6
Mode of examination	20 marks for Test / Quiz / Assignment / Seminar. 05 marks for Class Interaction	

Weightage Distribution	CA	CE	ESE	
	25	25	50	

| Text book/s* | 1. Vogel, A.I. 1989: Vogels textbook of quantitative chemical analysis. Wiley,Chichester. 2. Sodhi, GS 2005: Fundamental of Environmental Chemistry. Narosa Publishing House New Delhi | |

Course Articulation Matrix

Cos	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3
CO1	3	3	2	1	2	2	3	2	2	2	1	1	3	-
CO2	2	3	3	3	1	1	3	2	2	2	2	3	3	-
CO3	3	3	2	1	1	2	3	2	2	1	1	1	3	-
CO4	3	2	2	2	1	1	3	2	2	2	1	2	3	-
CO5	3	3	1	1	1	2	3	2	2	2	1	1	3	-
CO6	3	3	2	1	1	2	3	2	2	1	2	1	3	-

1-Slight (Low)   2-Moderate (Medium)   3-Substantial (High)

Environment Microbiology Lab

School: SSBSR	Batch: 2023-2027	
Programme: B.Sc.	Current Academic Year: 2024-2025	
Branch: Environmental Sciences	SEMESTER: III	
1	Course Code	BEN253
2	Course Title	**Environment Microbiology Lab**
3	Credits	1
4	Contact Hours(L-T-P)	0-0-2
5	Course Status	Minor / Elective
6	Course Objective	1 Diversity of Microbial habitat 2 Microbial interactions 3 Microbiology of air, soil and water
7	Course Outcomes	After studying this course, students will be able to CO1: To acquire the basic knowledge for the determination of moisture content andwater holding capacity of soil. CO2: Analysis of the percolation capacity and capillary action of soil. CO3: To identify and understand isolation of fungi and bacteria from soil. CO4: To identify and understand isolation of fungi and bacteria from rhizosphereCO5: To identify and understand isolation of fungi and bacteria from rhizoplane.CO6: To acquire an overall understanding of Environmental Microbiology
8	Course Description	The course comprises of general and basic features of microbial ecology, microbiology of air, water and soil. This also focussed on microbiology and its usein effluent treatment.
9	Outline syllabus		CO Mapping
	Unit 1	**Soil Analysis**	
	A	Analysis of moisture content of Soil.	CO1
	B & C	Analysis of water holding capacity of Soil.	CO1
	Unit 2	**Determination of percolation capacity of Soil**	
	A	To Determine percolation capacity of Soil.	CO2
	B & C	Determination of capillary action of Soil.	CO2
	Unit 3	**Isolation of Fungi and Bacteria from Soil**	
	A	Isolation of fungi from soil (28^0C and 45^0C)	CO3/CO6
	B & C	Isolation of bacteria from soil (28^0C and 45^0C)	CO3/CO6
	Unit 4	**Isolation of Fungi and Bacteria from Rhizosphere**	
	A	Isolation of bacteria from rhizosphere	CO4/CO6
	B & C	Isolation of fungi from rhizosphere.	CO4/CO6

Unit 5	**Isolation of Fungi and Bacteria from Rhizosplane**	
A	Isolation of bacteria from rhizoplane.	CO5/CO6
B & C	Isolation of fungi from rhizoplane.	CO5/CO6
Mode of examination	Theory	
Weightage Distribution	CA	CE	ESE	
	25	25	50	
Text book/s*	1. Southworth, H.M. (1982) Introduction tomodern microscopy. 2. Willard, H.H., Meritt, L.L., Dean, J.A. and Settle, F.A. (1986) Instrumental Methods ofAnalysis. 3. Plumer, D.T. (1979) An Introduction toPractical Biochemistry	
Other References	Environmental Sciences earth as a living planet byDaniel K. Botkin and Edward A. Keller, Third edition, John Wiley and Sons, LTD, U.S.A.	

Course Articulation Matrix

Cos	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3
CO1	3	3	2	1	2	2	3	2	2	2	1	2	3	-
CO2	2	3	3	3	1	1	3	2	2	2	2	1	3	-
CO3	3	3	2	1	1	2	3	2	2	1	1	1	3	-
CO4	3	2	2	2	1	1	3	2	2	2	1	1	3	-
CO5	3	3	1	1	1	2	3	2	2	2	1	1	3	-
CO6	3	3	2	1	1	2	3	2	2	1	2	1	3	-

1-Slight (Low)   **2-Moderate (Medium)**   **3-Substantial (High)**

Logical Skills Building and Soft Skills

Schools: SET/SOL/SMFE/SOE/SAP	Batch 2023-2027
	Current Academic year 2024-25
	Semester III
Course Code	ARP207
Course Title	Logical Skills Building and Soft Skills
Credits	2
Contact Hours (L-T-P)	0-1-2
Course Objective	To enhance holistic development of students and improve their employability skills. To provide a 360 degree exposure to learning elements of Business English readiness Programme, behavioural traits, achieve softer communication levels and a positive self-branding along with augmenting numerical and altitudinal abilities. To step up skill and upgrade students' across varied industry needs to enhance employability skills. By the end of this semester, a student will have entered the threshold of his/her 1st phase of employability enhancement and skill building activity exercise.
Course Outcomes	After completion of this course, students will be able to: CO1: Ascertain a competency level through Building Essential Language and Life Skills CO2: Build positive emotional competence in self and learn GOAL Setting and SMART Goals techniques CO3: Apply positive thinking, goal setting and success-focused attitudes, time Management, which would help them in their academic as well as professional career CO4: Acquire satisfactory competency in use of aptitude, logical and analytical reasoning CO5: Develop strategic thinking and diverse mathematical concepts through building number puzzles CO6: Demonstrate an ability to apply various quantitative aptitude tools for making business decisions
Course Description	This Level 1 blended training approach equips the students for Industry employment readiness and combines elements of soft skills and numerical abilities to achieve this purpose.

Outline syllabus – ARP 207		CO Mapping
Unit 1	**BELLS (Building Essential Language and Life Skills)**	
A	Know Yourself: Core Competence. A very unique and interactive approach through an engaging questionnaire to ascertain a student's current skill level to design, architect and expose a student to the right syllabus as also to identify the correct TNI/TNA levels of the student.	CO1
B	Techniques of Self Awareness | Self Esteem & Effectiveness| Building Positive Attitude | Building Emotional Competence	CO1, CO2
C	Positive Thinking & Attitude Building | Goal Setting and SMART Goals – Milestone Mapping | Enhancing L S R W G and	CO1, CO2,CO3

	P (Listening Speaking Reading Writing Grammar and Pronunciation)		
Unit 2	Introduction to APTITUDE TRAINING- Reasoning- Logical/ Analytical	
A	Syllogism	Letter Series	Coding, Decoding , Ranking & Their Comparison Level-1	CO4
B	Number Puzzles	CO5
C	Selection Based On Given Conditions	CO5
Unit 3	Quantitative Aptitude	
A	Number Systems Level 1	Vedic Maths Level-1	CO6
B	Percentage ,Ratio & Proportion	Mensuration - Area & Volume	Algebra	CO6
Unit 4	Verbal Abilities – 1	
A	Reading Comprehension	CO1
B	Spotting the Errors	CO2
Unit 5	Time & Priority Management	
A	Steven Covey Time Management Matrix	CO3
B	Creating Self Time Management Tracker	CO3
Weightage Distribution	Class Assignment/Free Speech Exercises / JAM – 60%	Group Presentations/Mock Interviews/GD/ Reasoning, Quant & Aptitude – 40%	
Text book/s*	Wiley's Quantitative Aptitude-P Anand	Quantum CAT – Arihant Publications	Quicker Maths- M. Tyra	Power of Positive Action (English, Paperback, Napoleon Hill)	Streets of Attitude (English, Paperback, Cary Fagan, Elizabeth Wilson) The 6 Pillars of self-esteem and awareness – Nathaniel Brandon	Goal Setting (English, Paperback, Wilson Dobson	

Course Articulation Matrix

Cos	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3
CO1	1	-	1	1	-	-	-	-	-	-	-	-	-	-
CO2	1	-	1	1	-	-	-	-	-	-	-	-	-	-
CO3	1	-	1	1	-	-	-	-	-	-	-	-	-	-
CO4	1	-	1	1	-	-	-	-	-	-	-	-	-	-
CO5	1	-	1	1	-	-	-	-	-	-	-	-	-	-
CO6	1	-	1	1	-	-	-	-	-	-	-	-	-	-

1-Slight (Low)   **2-Moderate (Medium)**   **3-Substantial (High)**

RBL001 Research Based Learning-1

School: SSBSR	**Batch: 2023-2027**		
Programme: Diploma	**Current Academic Year: 2024-2025**		
Branch:	**Semester III**		
1	Course Code	**RBL001**	
2	Course Title	Research Based Learning 1	
3	Credits	Audit Based	
4	L-T-P	0-0-4	
	Course Status	Compulsory	
5	Course Objective	Develop an interest towards research	
6	Course Outcomes	**CO 1:** Recognize research-based investigation carried outon problems in physics and interdisciplinary science	
		CO 2: Comprehend and compare a research article with areview article or a survey-based article	
		CO 3: Demonstrate capacity to follow research articles	
		CO 4: Identify concepts of Environmental science referred in researcharticles	
		CO 5: Extract important results of research findings	
		CO 6: Report research findings in written and verbal forms	
7	Course Description	Reading in a field of special interest under the supervision ofa faculty member. Intended for students interested in studying topics not offered in regularly available courses. Formatand grading are determined by the supervising faculty member and the audit members then approved by the Head of Department.	
8	Outline		CO Achievement
	Part 1	**Introduction to various research problems**	**CO1**
	Part 2	**Identify a research question**	**CO2, CO3**
	Part 3	**Literature survey**	**CO4**
	Part 4	**Report writing**	**CO5**
	Part 5	**Presentation**	**CO6**

Mode of examination	1. Rubric assessment 2. Monthly Presentation to be audited by supervisor 3. Mid Term Presentation and End Term Presentation	
Text book/s*	10 Recent International Journal Articles of repute.	
Other References		

Course Articulation Matrix

Cos	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3
CO1	3	3	2	1	2	2	3	2	2	2	1	2	2	1
CO2	2	3	3	3	1	1	3	2	2	2	2	1	1	2
CO3	3	3	2	1	1	2	3	2	2	1	1	1	1	1
CO4	3	2	2	2	1	1	3	2	2	2	1	1	1	1
CO5	3	3	1	1	1	2	3	2	2	2	1	1	1	1
CO6	3	3	2	1	1	2	3	2	2	1	2	1	1	2

1-Slight (Low)   **2-Moderate (Medium)**   **3-Substantial (High)**

Green Technologies

School: SSBSR	Batch: 2023-2027	
Programme: B.Sc.	Current Academic Year: 2024-2025	
Branch: Environmental Sciences	SEMESTER: IV	
1	Course Code	**BEN204**
2	Course Title	**Green Technologies**
3	Credits	4
4	Contact Hours (L-T-P)	4-0-0
4	Course Status	Compulsory
5	Max. Marks	15+15+75 = 100
6	Min. Marks	
7	Course Objective	This paper introduces students to the concept of green technology, its goals and advantages.
8	Course Outcomes	CO1: Classify and understand the principles of Energy efficient technologies CO2: Understand the roll of green infrastructure. CO3: Knowledge about applications of green technologies. CO4: Identify the principles of green chemistry CO5: Explain the benefits of green Technologies with respect to sustainable development. CO6: Explain the potential of green technologies to tap the economic benefits and to achieve sustainable development.
9	Course Description	It highlights potential role of green technologies in realizing the goal of sustainable development and focuses on community participation to tap the economic benefits associated with switching to green technologies.
10	Outline syllabus		CO Mapping
	Unit 1	**Introduction**	
	A	Definition and concepts: green technology, green energy, green infrastructure, green economy, and, green chemistry; sustainable consumption of resources	CO1
	B	Individual and community level participation such as small-scale composting pits for biodegradable waste, energy conservation; encouraged use of public transport instead of private transport	CO1

C	Green technologies in historical and contemporary perspectives; successful green technologies: wind turbines, solar panels; 3 R's of green technology: recycle, renew and reduce	CO1
Unit 2	**Green Infrastructure, Planning and Economy**	
A	Green buildings; history of green buildings, need and relevance of green buildings over conventional buildings, construction of green buildings; associated costs and benefits; outlined examples of green buildings; LEED certified building	CO2
B	Eco-mark certification, establishment of Eco-mark in India, its importance and implementation; Green planning: role of governmental bodies, land use planning, concept of green cities, waste reduction and recycling in cities	CO2
C	Role of informal sector in waste management, public transportation for sustainable development, green belts; Introduction to UNEP's green economy initiative, inclusive economic growth of the society, REDD+ initiative, and cap and trade concept; green banking	CO2
Unit 3	**Applications of Green Technologies**	
A	Increase in energy efficiency: cogeneration, motor system optimization, oxy-fuel firing, isothermal melting process, energy efficient fume hoods, compact fluorescent lights (CFLs), motion detection lighting, or Programmable thermostats)	CO3/ CO6
B	Green House Gas (GHG) emissions reduction: carbon capture and storage (CCS) technologies, purchase and use of carbon offsets, promotion and/or subsidy of alternative forms of transportation for employees, such as carpools, fuel efficient vehicles, and mass transit, methane emissions reduction and/or reuse)	CO3/ CO6
C	Pollution reduction and removal (Flue Gas Desulfurization (FGD) methods, catalytic or thermal destruction of NOX, Fluidized Bed Combustion, Dioxins reduction and removal methods, Thermal Oxidizers or Wet Scrubbers to neutralize chemicals or heavy metals, solvent recovery systems, Low Volatile Organic Compound (VOC) paints and sealers)	CO3/ CO6
Unit 4	**Green Chemistry**	
A	Introduction to green chemistry; principles and recognition of green criteria in chemistry	CO4/ CO6
B	Green Nanomaterials: Exploring sustainable nanomaterials and their characteristics, Synthesis methods specifically focused on producing green nanomaterials.	CO4/ CO6
C	Characterization techniques tailored for analyzing and assessing green nanomaterials	CO4/ CO6
Unit 5	**Green Future**	

A	Agenda of green development; reduction of ecological footprint; role of green technologies towards a sustainable future; major challenges and their resolution for implementation of green technologies	CO5/ CO6
B	Green practices to conserve natural resources (organic agriculture, agroforestry, reducing paper usage and consumption, etc.); emphasis on waste reduction instead of recycling	CO5/ CO6
C	Emphasis on innovation for green future; role of advancement in science in developing environmental friendly technologies	CO5/ CO6
Mode of examination	20 marks for Test / Quiz / Assignment / Seminar. 05 marks for Class Interaction	

Weightage Distribution	CA	MSE	ESE	
	15	10	75	

| Text book/s* | 1. Arceivala, S.L. 2014. Green Technologies: For a Better Future. Mc-Graw Hill Publications.
2. Baker, S. 2006. Sustainable Development. Routledge Press
3. Thangavel, P. & Sridevi, G. 2015. Environmental Sustainability: Role of Green Technologies. Springer Publications.
4. Woolley, T. & Kimmins, S. 2002. Green Building Handbook (Volume 1 and 2). Spon Press | |

Course Articulation Matrix

Cos	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3
CO1	3	3	2	1	2	2	3	2	2	2	1	-	3	2
CO2	2	3	3	3	1	1	3	2	2	2	2	-	3	1
CO3	3	3	2	1	1	2	3	2	2	1	1	-	3	2
CO4	3	2	2	2	1	1	3	2	2	2	1	-	3	1
CO5	3	3	1	1	1	2	3	2	2	2	1	-	3	2
CO6	3	3	2	1	1	2	3	2	2	1	2	-	3	2

1-Slight (Low)   2-Moderate (Medium)   3-Substantial (High)

School: SSBSR	Batch: 2023-2027
Programme: B.Sc.	Current Academic Year: 2024-25
Branch: Environmental Sciences	Semester: IV
1	Course Code	BEN205
2	Course Title	**Air Pollution and Technology**
3	Credits	3
4	Contact Hours (L-T-P)	3-0-0
	Course Status	Compulsory
5	Course Objective	1. On the completion of the course one should be able to understand: 2. Concepts of air pollution. 3. How to estimate the quantity of air pollutant. 4. Be able to develop control technologies.
6	Course Outcomes	After the successful completion of this course students will be able to:CO1: To Define the air pollution CO2: Explain the air pollution CO3: Identify the causes of air pollution. CO4: Analysis he types of air pollution. CO5: Determine the impact of air pollution. CO6: Develop the air quality sampling modeling
7	Course Description	The main aim of the course is to provide students with a scientific and technical background in air pollution monitoring, pollution control technologies and environmental management. This OCW course is especially focused on industrial processes and plants. Students will also be introduced to the European legislative framework on air quality and to international conventions.
8	Outline syllabus		CO Mapping
	Unit 1	**Introduction**	
	A	History of Air pollution and episodes, Sources of air pollution and types, Introduction to meteorology and transport of air pollution	CO1
	B	Global winds, wind rose terrestrial windprofile	CO1
	C	Effects of terrain and topography on winds, lapse rate, maximum mixing depths, plume rise	CO1
	Unit 2	**Transport of Pollution in Atmosphere**	
	A	Plume behavior under different atmospheric conditions, Mathematical models of dispersion of air pollutants	CO2
	B	Plume behavior in valley and terrains	CO2
	C	Plume behavior under different meteorological conditions	CO2
	Unit 3	**Effects of Air Pollution**	

A	Effects of Air Pollution on human beings, plants and animals and Properties. Global Effects-Greenhouse effect		CO3/CO6
B	Ozone depletion, heat island, dust storms, Automobile pollution sources and control,		CO3/CO6
C	Photochemical smog, Future engines and fuels		CO3/CO6
Unit 4	**Air Pollution Control**		
A	Air Pollution control- at source-equipment for control of air pollution-For particulate matter-Settling Chambers-Fabric Filters-Scrubbers-Cyclones Electrostatic precipitators		CO4/CO6
B	For Gaseous pollutants-control by absorption-adsorption scrubbers- secondary combustion after burners		CO4/CO6
C	Working principles advantages and disadvantages, design criteria and examples.		CO4/CO6
Unit 5	**Air Quality Sampling and Monitoring**		
A	Stack sampling, instrumentation and methods of analysis of SO2, CO		CO5/CO6
B	Legislation for control of air pollution		CO5/CO6
C	Automobile pollution		CO5/CO6
Mode of examination	Theory		
Weightage Distribution	CA	MSE	ESE
	15	10	75
Textbook/s*	Martin Crawford, Air Pollution Control Theory, TMH Publ.		
Other References	1. H.C Parkins, Air Pollution Mc Graw Hill Publication 2. H.S. Peavy, D.R. Row & G. Tchobanoglous, Environmental Engineering, Mc Graw Hill International Edition		

Course Articulation Matrix

Cos	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3
CO1	3	3	2	1	2	2	3	2	2	2	1	2	2	1
CO2	2	3	3	3	1	1	3	2	2	2	2	1	1	1
CO3	3	3	2	1	1	2	3	2	2	1	1	1	2	1
CO4	3	2	2	2	1	1	3	2	2	2	1	1	1	1
CO5	3	3	1	1	1	2	3	2	2	2	1	1	2	1
CO6	3	3	2	1	1	2	3	2	2	1	2	1	2	1

1-Slight (Low)   **2-Moderate (Medium)**   **3-Substantial (High)**

Foundations & Perspectives of Sustainable Development

School: SSBSR	**Batch: 2023-2027**	
Programme: B.Sc.	**Current Academic Year: 2024-25**	
Branch: Environmental Sciences	**Semester: IV**	
1	Course Code	**BEN206**
2	Course Title	**Foundations & Perspectives of Sustainable Development**
3	Credits	5
4	Contact Hours (L-T-P)	5-0-0
	Course Status	Minor/ Elective
5	Course Objective	This paper introduces students to the concept of sustainable development and its issues
6	Course Outcomes	CO1: Understand the glimpse of history of sustainable development CO2: Develop an encompassing understanding of sustainability issues. CO3: Understand the basic concept of Sustainable Development (SD), the environmental, social and economic dimensions CO4: Understand the embedment of sustainability issues in environmental, societal, and economic systems, and the relevance of the conditions, interrelations,and dynamics of these systems. CO5: Be familiar with potential strategic options for SD(efficiency, sufficiency). CO6: Overall understanding and ability to assess the sustainable practices of any community based on metrics
7	Course Description	It highlights how sustainability considerations can actually be embedded withinan individual's and community's day to day activities and decision-making processes It also assesses existing sustainable development tools and methods can be adjusted/fine-tuned accordingly
8	Outline syllabus		CO Mapping

Unit 1	**Introduction to Sustainable Development: Glimpse into Historyand Current practices**	
A	Broad introduction to SD - its importance, need, impact andimplications	CO1
B	Definition coined; evolution of SD perspectives (MDGs ANDSDGs) over the years; recent debates	CO1
C	1987 Brundtland Commission and outcome; later UN summits (Riosummit, etc.) and outcome	CO1
Unit 2	**Ecosystem & Sustainability**	
A	Fundamentals of ecology-types of ecosystems & interrelationships, factors influencing sustainability of	

		ecosystems	CO2
	B	Ecosystem restoration-developmental needs. Introduction to sustainability & its factors, requirements for sustainability: food security and agriculture,	CO2
	C	Renewable resources - water and energy, non-renewable resources,factors and trade-offs, sustainability conflicts, a conceptualframework for linking sustainability and sustainable development.	CO2
Unit 3		**Dimensions to Sustainable Development**	
	A	Society, environment, culture and economy; current challenges -natural, political, socio-economic imbalance;	CO3/CO6
	B	Sustainable development initiatives and policies of variouscountries	CO3/CO6
	C	Global, regional, national, local; needs of present and futuregeneration - political, economic, environmental.	CO3/CO6
Unit 4		**Gauging Sustainable Development**	
	A	Sustainability and development indicators and SDGs, UN's outlookof sustainable development and efforts, UN SDGs - structure, governance and partnerships; communities / society	CO4/CO6
	B	Ensuring resilience and primary needs in society; biosphere:development within planetary boundaries;	CO4/CO6
	C	Strengthening institutions for sustainability; shaping a sustainableeconomy	CO4/CO6
Unit 5		**Frameworks of Sustainability**	
	A	Analytical frameworks in sustainability studies, sustainabilitymetrics: criteria and indicators	CO5/CO6
	B	The significance of quantitative and qualitative assessments ofsustainability; current metrics and limitations	CO5/CO6
	C	Metrics for mapping and measuring sustainable development;application of the metrics in real scenarios	CO5/CO6
Mode of examination	Theory		
Weightage Distribution	CA	MSE	ESE
	15	10	75
Textbook/s*	Martin Crawford, Air Pollution Control Theory, TMH Publ.		
Other References	1. Franco, I.B. and Tracey, J. (2019), "Community capacity- building for sustainable development: Effectively striving towards achieving local community sustainability targets", International Journal of Sustainability in Higher Education,Vol.		

20 No. 4, pp.691-725
2. Our Common Journey: A Transition Toward Sustainability. National Academy Press, Washington D.C. Soubbotina, T. P. 2004.
3. Elliott, Jennifer. 2012. An Introduction to Sustainable Development. 4th Ed. Routledge, London

Course Articulation Matrix

Cos	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3
CO1	3	3	2	1	2	2	3	2	2	2	1	2	2	1
CO2	2	3	3	3	1	1	3	2	2	2	2	1	2	2
CO3	3	3	2	1	1	2	3	2	2	1	1	1	1	1
CO4	3	2	2	2	1	1	3	2	2	2	1	1	2	1
CO5	3	3	1	1	1	2	3	2	2	2	1	1	2	1
CO6	3	3	2	1	1	2	3	2	2	1	2	1	1	2

1-Slight (Low)   **2-Moderate (Medium)**   **3-Substantial (High)**

Data Ware Housing & Data Mining

School: SSBSR	Batch: 2023-27	
Programme: B.Sc.	Academic Year: 2024-25	
Branch: Environment alSciences	Semester: IV	
1	Course Code	**BDA218**
2	Course Title	**Data Ware Housing & Data Mining**
3	Credits	3
4	Contact Hours(L-T-P)	3-0-0
	Course Status	Minor / Elective
5	Course Objective	Familiarise students with basic concepts of data warehousing, business analysis, data mining, association rule mining and classification, clustering, and trends in data mining.
6	Course Outcomes	CO1: Discuss the Data warehousing Components, Cleanup, and transformation Tools - Metadata. (K3, K5) CO2: Explain methods of business analysis, reporting, and query tools and applications. (K2, K3, K4) CO3: Describe the OLAP guideline multidimensional versus multi relational OLAP, categories of tools, OLAP tools, and the internet. (K2, K4) CO4: Explain and illustrate data mining functionalities, the interestingness of patterns, integration of a data mining system with data warehouse issues, and data preprocessing. (K2, K3) CO5: Explain the basic concepts of decision tree induction, bayesian classification, rule-based classification, classification by backpropagation and apply support vector machines, associative classification, lazy learners, other classification methods, and prediction. (K2, K3, K4) CO6: Explain and evaluate clustering and trends in data mining. (K2, K4, K6)
7	Course Description	This course introduces the basic concepts of data warehousing, business analysis, data mining, association rule mining and classification, clustering, and trends in data mining.

8	**Outline syllabus**		**CO Mapping**
	Unit 1	**Data Warehousing**	
	A	Data warehousing Components –Building a Data warehouse.	CO1
	B	Mapping the Data Warehouse to a Multiprocessor Architecture – DBMS Schemas for Decision Support	CO1
	C	Data Extraction, Cleanup, and Transformation Tools - Metadata.	CO1
	Unit 2	**Business Analysis**	CO2, CO3
	A	Reporting and Query tools and Applications, Cognos Impromptu, Online Analytical Processing (OLAP).	CO3
	B	Multidimensional Data Model, OLAP Guideline Multidimensional versus Multirotational OLAP,	CO3
	C	Categories of Tools, OLAP Tools, and the Internet.	
	Unit 3	**Data Mining**	CO4

	A	Introduction, Data, Types of Data, Data Mining Functionalities,	CO4
	B	Interestingness of Patterns, Classification of Data Mining Systems, Data Mining Task Primitives,	CO4
	C	Integration of a Data Mining System with Data Warehouse Issues, Data Preprocessing	
Unit 4		**Association Rule Mining and Classification**	CO5
	A	Mining Frequent Patterns, Associations and Correlations, Mining Methods, Mining various Kinds of Association Rules, Correlation Analysis,	CO5
	B	Constraint-Based Association Mining Classification and Prediction, Basic Concepts, Decision Tree Induction, Bayesian Classification, Rule Based Classification, Classification by Backpropagation,	CO5
	C	Support Vector Machines, Associative Classification, Lazy Learners, Other Classification Methods, and Prediction.	
Unit 5		**Clustering and Trends in Data Mining**	CO6
	A	Cluster Analysis, Types of Data, Categorization of Major Clustering Methods, K-means, Partitioning Methods, Hierarchical Methods,	CO6
	B	Density-Based Methods, Grid-Based Methods, Model-Based Clustering Methods, Clustering High Dimensional Data, Constraint, Based Cluster Analysis, and Outlier Analysis.	CO6
	C	Data Mining Applications. Apply data mining techniques and methods to large data sets, use data mining tools, and Compare and contrast the various classifiers.	
Mode of examination	Theory		
Weightage Distribution	CA: 25%; MTE: 25%; ETE:50%		
Text book/s*	1. Alex Berson and Stephen J. Smith, "Data Warehousing, Data Mining and OLAP", Tata McGraw – Hill Edition, Thirteenth Reprint 2008. 2. Jiawei Han and Micheline Kamber, "Data Mining Concepts and Techniques", Third Edition, Elsevier, 2012.		
Other References	1. Pang-Ning Tan, Michael Steinbach, and Vipin Kumar, "Introduction to Data Mining", Person Education, 2007. 2. K.P. Soman, Shyam Diwakar and V. Aja, "Insight into Data Mining Theory and Practice", Eastern Economy Edition, Prentice Hall of India, 2006. 3. G. K. Gupta, "Introduction to Data Mining with Case Studies", Eastern Economy Edition, Prentice Hall of India, 2006. 4. Daniel T.Larose, "Data Mining Methods and Models", Wiley-Interscience, 2006.		

Course Articulation Matrix

Cos	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3
CO1	2	1	2	-	1	-	-	-	-	-	-	-	-	-
CO2	2	1	2	-	1	-	-	-	-	-	-	-	-	-
CO3	2	1	2	-	1	-	-	-	-	-	-	-	-	-
CO4	2	1	2	-	1	-	-	-	-	-	-	-	-	-
CO5	2	1	2	-	1	-	-	-	-	-	-	-	-	-
CO6	2	1	2	-	1	-	-	-	-	-	-	-	-	-

1-Slight (Low)   **2-Moderate (Medium)**   **3-Substantial (High)**

Analytical Lab II

School: SSBSR	**Batch: 2023-2027**	
Programme: B.Sc.	**Current Academic Year: 2024-2025**	
Branch: Environmental Sciences	**SEMESTER: IV**	
1	Course Code	**BEN254**
2	Course Title	**Analytical Lab II**
3	Credits	2
4	Contact Hours (L-T-P)	0-0-2
4	Course Status	Compulsory
5	Max. Marks	25+25+50 = 100
6	Min. Marks	
7	Course Objective	To give knowledge about quantitative and qualitative analysis of soil and water
8	Course Outcomes	CO1: Estimation of properties of soil. CO2: Determination of effect of light intensity on plant growth. CO3: Determination of amount of dust deposited on plants and alkalinity of soil. CO4: Estimation of Ferrous content and chloride content from water sample. CO5: Predict the rate of removal of suspended solids from wastewater. CO6: Determination of physical and chemical properties of soil and water.
9	Course Description	Knowledge about quantitative and qualitative analysis of soil and water
10	Outline syllabus		CO Mapping
	Unit 1	**Analysis of Soil Sample**	
	A	To determine texture of various soil samples.	CO1
	B and C	To determine the pH of given soil samples.	CO1

	Unit 2	**Analysis of Physical Properties of Plants**	
	A	To study the effect of light intensity on the growth of plants.	CO2
	B	To study the soil physical properties and their influence on plant growth	CO2
	Unit 3	**Analysis of Chemical Properties of Plants**	
	A	To estimate the amount of dust (particulate matter) deposition on the leaves of roadside plants	CO3/CO6
	B and C	To determine the alkalinity of given soil sample.	CO3/CO6
	Unit 4	**Analysis of Chemical Properties of Water**	
	A	To determine the ferrous content in the supplied sample of iron ore by titrimetric analysis against standard $K_2Cr_2O_7$ solution using $K_3[Fe (CN)_6]$ as an external indicator.	CO4/CO6
	B and C	To determine the chloride content in given water sample by Mohr's method.	CO4/CO6
	Unit 5	**Determination of the Acidity of Water Sample**	
	A	Jar Test (removal of suspended solids by coagulation, e.g. use of alum)	CO5/CO6
	B and C	To determine the acidity of water sample	
	Mode of examination	20 marks for Test / Quiz / Assignment / Seminar. 05 marks for Class Interaction	

	Weightage Distribution	CA	CE	ESE	
		25	25	50	
	Text book/s*	1. Brady NC 1990: The nature and properties of Soil. Mac Millan publishing Company New York. 2. Baruah, T.C and Barthakur, H.P. 1997: A text book of soil analysis. Vikas, New Delhi. 3. Vogel, A.I. 1989: Vogels textbook of quantitative chemical analysis. Wiley, Chichester.	

Course Articulation Matrix

Cos	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3
CO1	3	3	2	1	2	2	3	2	2	2	1	2	2	-
CO2	2	3	3	3	1	1	3	2	2	2	2	1	1	-
CO3	3	3	2	1	1	2	3	2	2	1	1	2	1	-
CO4	3	2	2	2	1	1	3	2	2	2	1	1	1	-
CO5	3	3	1	1	1	2	3	2	2	2	1	2	1	-
CO6	3	3	2	1	1	2	3	2	2	1	2	2	1	-

1-Slight (Low)   **2-Moderate (Medium)**   **3-Substantial (High)**

Air Pollution and Technology Lab		
	School: SSBSR	**Batch 2023-2027**
	Programme: B. Sc.	**Current Academic Year 2024-25**
	Branch: Environmental Sciences	**Semester IV**
	Course Code	**BEN255**
2	Course Title	**Air Pollution and Technology Lab**
3	Credits	1
4	Contact Hours (L-T-P)	0-0-2
5	Course Status	Compulsory
6	Course Objective	1. Understand issues related to the Environment 2. Acquire basic understanding of another component of environment 3. Understand issues related to the Atmosphere
7	Course Outcomes	After studying this course, students will be CO1: Able to understand the Particulate Matter Sampler CO2: Able to acquire basic understanding of Gaseous and Heavy Metal Sampler CO3: To identify and understand the working of RDS and HVS CO4: To understand the calculation of NO2 and SO2 in ambient air CO5: To understand the calculation of NH3 and O3 in ambient air CO6: Overall understanding of Air Pollution and Technology Lab
8	Course Description	The successful graduate will be prepared for entry-level positions within a wide knowledge of climate and environment

9	Outline syllabus		CO Mapping
	Unit 1	**Demonstration of Particulate Matter Sampler**	
	A	Demonstration of Respirable Dust Sampler (RDS)	CO1
	B	Demonstration of High-Volume Sampler (HVS)	CO1
	Unit 2	**Demonstration of Gaseous and Heavy Metal Sampler**	
	A	Demonstration of Gaseous Sampler	CO2
	B	Demonstration of Heavy Metal Sampler	CO2
	Unit 3	**Calculate the Concentration of Particulate Matter in Ambient Air**	
	A	Calculate the Concentration of PM10 in Ambient Air	CO3/CO6
	B	Calculate the Concentration of PM2.5 in Ambient Air	CO3/CO6
	Unit 4	**Calculate the Concentration of Gaseous Pollutants in Ambient Air**	
	A	Calculate the Concentration of Nitrogen Dioxide in Ambient Air	CO4/CO6
	B	Calculate the Concentration of Sulphur Dioxide in Ambient Air	CO4/CO6

Unit 5	Calculate the Concentration of Ammonia and Ground Level Ozone in Ambient Air	
A	Calculate the Concentration of Ammonia in Ambient Air	CO5/CO6
B	Calculate the Concentration of Ground Level Ozone in Ambient Air	CO5/CO6
Mode of examination	Theory	
Weightage Distribution	CA CE ESE 25 25 50	
Text book/s*	The Nature, Causes, Effects and Mitigation of Climate Change on the Environment (pp.1-16) Chapter: Global Warming and Climate Change (GWCC) Realities Publisher: IntechOpen Limited	
Other References	Global Warming and Climate Change (GWCC) realities	

Course Articulation Matrix

Cos	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3
CO1	3	3	2	1	2	2	3	2	2	2	1	-	3	-
CO2	2	3	3	3	1	1	3	2	2	2	2	-	3	-
CO3	3	3	2	1	1	2	3	2	2	1	1	-	3	-
CO4	3	2	2	2	1	1	3	2	2	2	1	-	3	-
CO5	3	3	1	1	1	2	3	2	2	2	1	-	3	-
CO6	3	3	2	1	1	2	3	2	2	1	2	-	3	-

1-Slight (Low)   **2-Moderate (Medium)**   **3-Substantial (High)**

RBL002 Research Based Learning-2

School: SSBSR	Batch: 2023-2027	
Programme: B. Sc.	Current Academic Year: 2024-25	
Branch: Environmental Sciences	Semester IV	
1	Course Code	RBL002	
2	Course Title	Research Based Learning 2	
3	Credits	Audit Based	
4	Contact Hours(L-T-P)	(0-0-2)	
	Course Status	Compulsory	
5	Course Objective	1. Develop knowledge of a specific area of specialization. 2. Develop research skills especially in project writing and oral presentation.	
6	Course Outcomes	**CO 1:** Articulate research-based investigation done on a topic **CO 2:** Demonstrate capacity to identify theoretical/ experimental method followed in the research articles **CO 3:** Demonstrate an understanding of the ethical issues associated with practitioner research **CO 4:** Compare research data and extract the outstanding results **CO 5:** Report research findings in written and verbal forms **CO 6:** Use research findings to advance education theory and practice	
7	Course Description	Reading in a field of special interest under the supervision of a faculty member. Intended for students interested in studying topics not offered in regularly available courses. Format and grading are checked by the supervising faculty member and the audit members then approved by the Head of Department.	
8	Outline		CO Achievement
	Part 1	Introduction to various research problems	CO1
	Part 2	Identify a research question	CO2, CO3
	Part 3	Literature survey	CO4/CO6
	Part 4	Report writing	CO5/CO6

Part 5	Presentation	CO6
Mode of examinatio n	1. Rubric assessment 2. Monthly Presentation to be audited by supervisor 3. Mid Term Presentation and End Term 4. Presentation	
Text book/s*	10 Recent International Journal Articles of repute.	
Other References	-	

Course Articulation Matrix

Cos	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3
CO1	3	3	2	1	2	2	3	2	2	2	1	1	2	1
CO2	2	3	3	3	1	1	3	2	2	2	2	2	1	-
CO3	3	3	2	1	1	2	3	2	2	1	1	1	2	1
CO4	3	2	2	2	1	1	3	2	2	2	1	1	1	1
CO5	3	3	1	1	1	2	3	2	2	2	1	1	2	-
CO6	3	3	2	1	1	2	3	2	2	1	2	2	2	-

1-Slight (Low)   **2-Moderate (Medium)**   **3-Substantial (High)**

School: SSBSR		Batch 2023-2027	
		Current Academic year 2024-25	
		Semester IV	
1	Course Code	ARP306	
2	Course Title	Campus to Corporate	
3	Credits	2	
4	Contact Hours (L-T-P)	1-0-2	
5	Course Objective	To enhance holistic development of students and improve their employability skills. Provide a 360 degree exposure to learning elements of Business English readiness Programme, behavioural traits, achieve softer communication levels and a positive self-branding along with augmenting numerical and altitudinal abilities. To up skill and upgrade students' across varied industry needs to enhance employability skills. By the end of this semester, a will have entered the threshold of his/her 4th phase of employability enhancement and skill building activity exercise.	
6	Course Outcomes	After completion of this course, students will be able to: CO1: Develop a creative, resumes, cover letters, interpret job descriptions and interpret KRA and KPI statements and art of conflict management. CO2: Build negotiation skills to get maximum benefits from deals in practical life scenarios. CO3: Develop skills of personal branding to create a brand image and self-branding CO4: Acquire higher level competency in use of logical and analytical reasoning such as direction sense, strong and weak arguments CO5: Develop higher level strategic thinking and diverse mathematical concepts through building analogies, odd one out CO6: Demonstrate higher level quantitative aptitude such as average, ratio & proportions, mixtures & allegation for making business decisions.	
7	Course Description	This penultimate stage introduces the student to the basics of Human Resources. Allows the student to understand and interpret KRA	KPI and understand Job descriptions. A student also understands how to manage conflicts, brand himself/herself, understand relations and empathise others with level-4 of quant, aptitude and logical reasoning	
8		Outline syllabus – ARP 306	CO Mapping
	Unit 1	Ace the Interview	CO MAPPING
	A	HR Sensitization (Role Clarity | KRA | KPI | Understanding JD)	Conflict Management	CO1
	B	Negotiation Skills	Personal Branding	CO3, CO4
	C	Uploading & Curating Resumes in Job Portals, getting Your Resumes Noticed	Writing Cover Letters	Relationship Management	CO1, CO3
	Unit 2	What is Personality?	Who Am I ? Creating a positive impression	
	A	Group Discussion, Email writing	CO4
	B	Personal Interviews and Mock PI's followed by personalised feedback	CO4

C	Story Telling and Analogies	CO5
Unit 3	**Accent neutralization and Power Dressing**	
A	JAM for confidence Building	CO6
B	MTI reduction - Phonetics (V and A)	CO6
C		CO6
Unit 4	**Written Communication**	
A	• Writing a Letter of Recommendation for Higher Studies	CO1
B	Email Etiquettes	CO2
Unit 5	**Problem Solving and Case Studies**	
A	Real time Case Study Solving Exercises	CO4
B	Intra student Mock Situation Handling Exercises	CO4
Evaluation Weightage	*(CA)Class Assignment/Free Speech Exercises / JAM – 60% | (ETE) Group Presentations/Mock Interviews(MIP's)/GD/ Reasoning, Quant & Aptitude– 40%*	
Text book/s*	*| Power of Positive Action (English, Paperback, Napoleon Hill) | Streets of Attitude (English, Paperback, Cary Fagan, Elizabeth Wilson) The 6 Pillars of self-esteem and awareness – Nathaniel Brandon | Goal Setting (English, Paperback, Wilson Dobson*	

Course Articulation Matrix

Cos	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3
CO1	-	-	1	-	-	-	-	1	-	1	-	-	-	-
CO2	-	-	1	-	-	-	-	1	-	1	-	-	-	-
CO3	-	-	1	-	-	-	-	1	-	1	-	-	-	-
CO4	-	-	1	-	-	-	-	1	-	1	-	-	-	-
CO5	-	-	1	-	-	-	-	1	-	1	-	-	-	-
CO6	-	-	1	-	-	-	-	1	-	1	-	-	-	-

1-Slight (Low)   **2-Moderate (Medium)**   **3-Substantial (High)**

Third Year
Detailed syllabus for
Bachelor
In
Environmental Sciences

Environmental Pollution and Health

School: SSBSR	**Batch: 2023-2027**		
Programme: B.Sc.	**Current Academic Year: 2025-26**		
Branch: Environmental Sciences	**SEMESTER: V**		
1	Course Code	**BEN301**	
2	Course Title	**Environmental Pollution and Human Health**	
3	Credits	3	
4	Contact Hours (L-T-P)	3-0-0	
4	Course Status	Compulsory	
5	Max. Marks	15+10+75 = 100	
6	Min. Marks		
7	Course Objective	To interpret and analyze different aspects of environmental contamination, whichhave adverse effects on human health.	
8	Course Outcomes	CO1: Evaluate the relations among environment, human, and health. CO2: Understand relationship among air pollution and human health CO3: Ability to suggest the environmental control /management plan for water pollution problems. CO4: Evaluate the relations among environment, human, and health for soil, radiation and thermal pollution. CO5: Interpret the relationship between Noise and Marine pollution and human health. CO6: identify and quantify the magnitude and intensity of Environmental pollution problems and their solution.	
9	Course Description	Understanding of different types of pollutants, their sources and mitigationmeasures.	
10	Outline syllabus		CO Mapping

	Unit 1	**Concept of Pollution, Bioaccumulation and Radioactivity**	
	A	Definition of pollution; pollutants; classification of pollutants. Solubility of pollutants (hydrophilic and lipophilic pollutants)	CO1
	B	Transfer of pollutants within different mediums, role of chelating agents in transferring pollutants, concept of bioaccumulation	CO1
	C	Concept of radioactivity, radioactive decay and half-life of pollutants, organometallic compounds, acid mine drainage	CO1
	Unit 2	**Air Pollution and Human Health**	
	A	Ambient air quality: monitoring and standards (National AmbientAir Quality Standards of India); air quality index	CO2
	B	Sources and types of pollutants (primary and secondary); smog (casestudy), indoor air pollution: sources and effects on human health	CO2
	C	Effects of different pollutants on human health (NOx, SOx, PM, CO,CO2, hydrocarbons and VOCs) and control measures	CO2
	Unit 3	**Water Pollution and Human Health**	
	A	Sources of surface and ground water pollution; water quality parameters and standards	CO3/ CO6
	B	Effect of water contaminants on human health(nitrate, fluoride, arsenic, chlorine, cadmium, mercury, pesticides)	CO3/ CO6
	C	Organic waste and water pollution; eutrophication, Water borne diseases	CO3/ CO6
	Unit 4	**Soil Pollution and Radioactive Pollution**	
	A	Causes of soil pollution and degradation; effect of soil pollution onenvironment, vegetation and other life forms; control strategies	CO4/ CO6
	B	Radioactive material and sources of radioactive pollution; effect ofradiation on human health (somatic and genetic effects)	CO4/ CO6
	C	Causes of thermal pollution, its effects on environment, aquatic lifeand human; control strategies	CO4/ CO6
	Unit 5	**Noise Pollution and Marine Pollution**	
	A	Noise pollution-sources; frequency, intensity and permissible ambient noise levels; effect on communication, impacts on life forms and humans - working efficiency, physical and mental health; control measures	CO5/ CO6
	B	Marine resources and their importance; sources of marine pollution;oil spill and its effects	CO5/ CO6
	C	Coral reefs and their demise; coastal area management	CO5/ CO6
	Mode of examination	20 marks for Test / Quiz / Assignment / Seminar.05 marks for Class Interaction	
	Weightage	CA	MSE	ESE	

Distribution	15	10	75	
Text book/s*	1. Gurjar, B.R., Molina, L.T. & Ojha C.S.P. 2010. Air Pollution:Health and Environmental Impacts. CRC Press, Taylor & Francis. 2. Hester, R.E. & Harrison, R.M. 1998. Air Pollution and Health.The Royal Society of Chemistry, UK 3. Pepper, I.L., Gerba, C.P. & Brusseau, M.L. 2006. Environmental and Pollution Science. Elsevier Academic Press.			

Course Articulation Matrix

Cos	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3
CO1	3	3	2	1	2	2	3	2	2	2	1	-	1	3
CO2	2	3	3	3	1	1	3	2	2	2	2	-	2	3
CO3	3	3	2	1	1	2	3	2	2	1	1	-	1	3
CO4	3	2	2	2	1	1	3	2	2	2	1	-	1	3
CO5	3	3	1	1	1	2	3	2	2	2	1	-	1	3
CO6	3	3	2	1	1	2	3	2	2	1	2	-	2	3

1-Slight (Low)   **2-Moderate (Medium)**   **3-Substantial (High)**

Natural Resource Management and Sustainability

School: SSBSR	**Batch: 2023-2027**	
Programme: B.Sc.	**Current Academic Year: 2026-2027**	
Branch: Environmenta lSciences	**SEMESTER: V**	
1	Course Code	**BEN302**
2	Course Title	**Natural Resource Management and Sustainability**
3	Credits	5
4	Contact Hours (L-T-P)	5-0-0
4	Course Status	Compulsory
5	Max. Marks	15+10+75 = 100
6	Min. Marks	
7	Course Objective	It aims to provide an idea of effective management strategies and a critical insight of the major sustainability issues
8	Course Outcomes	CO1: Describe resources, including human impacts that influence ecosystems change, natural succession and the future sustainability of natural resources. CO2: Identify forest, soil and water resources and methods of their conservation CO3: Explain mineral resources and their impacts on environment. CO4: List nonrenewable energy resources with their future perspectives. CO5: Discuss resource management to achieve the concept of sustainable development. CO6: knowledge of Earth's resources, their generation, extraction and impact of human activities on earth's environment with their management.
9	Course Description	This paper takes an objective view of the nature of Earth's resources, the generation, extraction and impact of human activities on earth's environment.

10	Outline syllabus		CO Mapping
	Unit 1	**Introduction**	
	A	Resource and reserves; classification of natural resources; renewable and non-renewable resources; resource degradation	CO1

B	Resource conservation; resource availability and factors influencing its availability; land resources; water resources	CO1
C	Energy resources; mineral resources; human impact on natural resources	CO1
Unit 2	**Natural resources and conservation**	
A	Forest resources: economic and ecological importance of forests, forest management strategies, sustainable forestry	CO2
B	Water resources: supply, renewal, and use of water resources, freshwater shortages, strategies of water conservation	CO2
C	Soil resources: importance of soil, soil conservation strategies; food resources: world food problem, techniques to increase world food production, green revolution	CO2
Unit 3	**Mineral resources**	
A	Mineral resources and the rock cycle; identified resources; undiscovered resources	CO3/CO6
B	Types of mining: surface, open-pit, dredging, strip; global consumption patterns of mineral resources techniques to increase mineral resource supplies	CO3/CO6
C	Ocean mining for mineral resources; environmental effects of extracting and using mineral resources	CO3/CO6
Unit 4	**Energy resources**	
A	Environmental impacts of non-renewable energy consumption; impact of energy consumption on global economy; application of green technology	CO4/CO6
B	Energy efficiency; life cycle cost; cogeneration; solar energy: technology, advantages, passive and active solar heating system, solar thermal systems, solar cells	CO4/CO6
C	Energy from biomass; bio-diesel, future energy options and challenges	CO4/CO6
Unit 5	**Resource management**	
A	Approaches in resource management: ecological approach; economic approach; ethnological approach; implications of the approaches	CO5/CO6
B	Integrated resource management strategies; concept of sustainability science: different approach towards sustainable development and its different constituents	CO5/CO6
C	Sustainability of society, resources and framework; sustainable energy strategy; principles of energy conservation; Indian renewable energy Programme	CO5/CO6

Mode of examination	20 marks for Test / Quiz / Assignment / Seminar. 05 marks for Class Interaction		
Weightage Distribution	CA	MSE	ESE
	15	10	75

Course Articulation Matrix

Cos	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3
CO1	3	3	2	1	2	2	3	2	2	2	1	2	1	3
CO2	2	3	3	3	1	1	3	2	2	2	2	2	2	3
CO3	3	3	2	1	1	2	3	2	2	1	1	1	1	3
CO4	3	2	2	2	1	1	3	2	2	2	1	2	1	3
CO5	3	3	1	1	1	2	3	2	2	2	1	2	1	3
CO6	3	3	2	1	1	2	3	2	2	1	2	1	2	3

1-Slight (Low)   **2-Moderate (Medium)**   **3-Substantial (High)**

Environmental Legislation and Policy

School: SSBSR	Batch: 2023-2027
Programme: B.Sc.	Current Academic Year: 2025-2026
Branch: Environmental Sciences	SEMESTER: V

1	Course Code	**BEN303**	
2	Course Title	**Environmental Legislation and Policy**	
3	Credits	4	
4	Contact Hours (L-T-P)	4-0-0	
4	Course Status	Compulsory	
5	Max. Marks	15+10+75 = 100	
6	Min. Marks		
7	Course Objective	This paper introduces students to the legal structure of India and fundamentals ofenvironmental legislation and policy making.	
8	Course Outcomes	CO1: Understand the fundamental rights and development of Environmental Lawsfrom ancient period. CO2: Explore the development of Environmental laws after independence. CO3: Explain the role of laws in the conservation and management of naturalresources as well as pollution control CO4: Describe the role of Government institutions in laws and policy making. CO5: Understanding laws and policies both at the national and international level relating to environment CO6: Identify core environmental issues and legal and institutional responses tothem	
9	Course Description	Will help the students to develop basic concepts of environmental legislation andpolicy making in India and around the world	
10	Outline syllabus		CO Mapping
	Unit 1	**Introduction**	
	A	Constitution of India; fundamental rights; fundamental duties; Union of India; union list, state list, concurrent list; legislature; state assemblies; judiciary; panchayats and municipal bodies	CO1

B	Ancient period: worship of water, air, trees; Mauryan period: Kautilya's Arthashastra, Yajnavalkyasmriti and Charaksamhita; Medieval period: forests as woodland and hunting resources during Mughal reign	CO1
C	British India: Indian Penal Code 1860, Forest Act 1865, Fisheries Act 1897	CO1
Unit 2	**Environmental legislation**	
A	Independent India: Van Mahotsava 1950, National Forest Policy 1952, Orissa River pollution and prevention Act 1953	CO2
B	Legal definitions (environmental pollution, natural resource,biodiversity, forest, sustainable development)	CO2
C	Article 48A (The protection and improvement of environment and safeguarding of forests and wildlife); Article 51 A (Fundamental duties)	CO2
Unit 3	**Legislative Instruments**	
A	The Indian Forest Act 1927; The Wildlife (Protection) Act 1972; The Water (Prevention and Control of Pollution) Act 1974	CO3/ CO6
B	The Forests (Conservation) Act 1980; The Air (Prevention and Control of Pollution) Act 1981	CO3/ CO6
C	The Environment (Protection) Act 1986; Motor Vehicle Act 1988	CO3/ CO6
Unit 4	**Government institutions and Case studies**	
A	Role of Ministry of Environment, Forests & Climate Change in environmental law and policy making; role of central and state pollution control boards in environmental law and policy making	CO4/ CO6
B	National Green Tribunal: Aditya N Prasad vs. Union of India & Others; Ganga Tanneries Case: M.C. Mehta vs. Union of India 1988	CO4/ CO6
C	Environmental education case: M.C. Mehta vs. Union of India, WP 860/1991	CO4/ CO6
Unit 5	**International laws and policy**	
A	Stockholm Conference 1972; United Nations Conference on Environment and Development 1992	CO5/ CO6

B	Rio de Janeiro (Rio Declaration, Agenda 21); Montreal Protocol 1987	CO5/ CO6
C	Kyoto Protocol 1997; Copenhagen and Paris summits; Ramsar convention	CO5/ CO6
Mode of examination	20 marks for Test / Quiz / Assignment / Seminar.05 marks for Class Interaction	
Weightage Distribution	CA	MSE	ESE	
	15	10	75	
Text book/s*	1 Gupta, K.R. 2006. Environmental Legislation in India. Atlantic Publishers and Distributors. 2. Leelakrishnan, P. 2008. Environmental Law in India (3rd edition). LexisNexis India. 3. Naseem, M. 2011. Environmental Law in India Mohammad. Kluwer Law International. Venkat, A. 2011. Environmental Law and Policy. PHI Learning Private Ltd	

Course Articulation Matrix

Cos	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3
CO1	3	3	2	1	2	2	3	2	2	2	1	-	-	2
CO2	2	3	3	3	1	1	3	2	2	2	2	-	-	1
CO3	3	3	2	1	1	2	3	2	2	1	1	-	-	2
CO4	3	2	2	2	1	1	3	2	2	2	1	-	-	1
CO5	3	3	1	1	1	2	3	2	2	2	1	-	-	2
CO6	3	3	2	1	1	2	3	2	2	1	2	-	-	2

1-Slight (Low)   **2-Moderate (Medium)**   **3-Substantial (High)**

Environmental Pollution and Human Health Lab

School: SSBSR	Batch: 2023-2027	
Programme: B.Sc.	**Current Academic Year:2025-2026**	
Branch: Environmen talSciences	**SEMESTER: V**	
1	Course Code	BEN351
2	Course Title	**Environmental Pollution and Human Health Lab**
3	Credits	1
4	Contact Hours (L-T-P)	0-0-2
4	Course Status	Compulsory
5	Max. Marks	25+25+50 = 100
6	Min. Marks	
7	Course Objective	This course will provide an insight into the physical and chemical characteristics of water sample
8	Course Outcomes	CO1: Estimation of DO and BOD in the water sample CO2: Estimation of carbon di-oxide in water samples. CO3: Estimation of pH and conductivity of soil samples. CO4: Determine water holding capacity of soil and jar test for water sample CO5: Estimation of dissolved solids and chlorides from water sample. CO6: Understand various physical and chemical water and soil quality parameters.
9	Course Description	It will give an insight into the soil properties and water quality
10	Outline syllabus		CO Mapping
	Unit 1	**Determination of Dissolved Oxygen of Tap and Ground Water**	
	A	Determination of dissolve oxygen content of water samples collected from tap and ground water.	CO1
	B and C	Determination of biochemical oxygen demand of the water samples collected from tap and ground water.	CO1

Unit 2			
A	Estimation of carbon di-oxide in water samples		CO2
B and C	Determination of water holding capacity of soil		CO2
Unit 3	**Determination of pH and Conductivity of soil sample**		
A	Determination of pH from soil samples		CO3/CO6
B and C	Determination of conductivity from soil samples		CO3/CO6
Unit 4	**Determination of Acidity and Alkalinity of soil sample**		
A	Determination of acidity of soil		CO4/CO6
B and C	Determination of alkalinity of soil		CO4/CO6
Unit 5	**Estimation of Dissolved Solids and Chlorides in WaterSample**		
A	Estimation of dissolved solids in water		CO5/CO6
B and C	Estimation of dissolved chlorides in water		CO5/CO6
Mode of examination	20 marks for Test / Quiz / Assignment / Seminar.05 marks for Class Interaction		
Weightage Distribution	CA	CE	ESE
	25	25	50
Text book/s*	1.Vogel, A. I. (1996). Textbook of Quantitative Chemical Analysis ELBS 5th Edn. 2. Mann, F. G. (2009). Practical organic chemistry. Pearson Education India. AI, V. (2005). Tatchell AR. Furnis BS. Hannaford AJ. Smith PWG. Vogel's Textbook of Practical Organic Chemistry Pearson		

Course Articulation Matrix

Cos	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3
CO1	3	3	2	1	2	2	3	2	2	2	1	-	1	3
CO2	2	3	3	3	1	1	3	2	2	2	2	-	2	3
CO3	3	3	2	1	1	2	3	2	2	1	1	-	1	3
CO4	3	2	2	2	1	1	3	2	2	2	1	-	1	3
CO5	3	3	1	1	1	2	3	2	2	2	1	-	1	3
CO6	3	3	2	1	1	2	3	2	2	1	2	-	2	3

1-Slight (Low)   **2-Moderate (Medium)**   **3-Substantial (High)**

Research Based Learning 3 (RBL3)

School: SSBSR		**Batch: 2023-2027**	
Programme: B. Sc.		**Current Academic Year: 2025-26**	
Branch: Environmental Sciences		**Semester V**	
1	Course Code	RBL003	
2	Course Title	Research Based Learning 3	
3	Credits	1	
4	Contact Hours(L-T-P)	(0-0-2)	
	Course Status	Compulsory	
5	Course Objective	• Develop knowledge of a specific area of specialization. • Develop research skills especially inproject writing and oral presentation.	
6	Course Outcomes	**CO1:** Apply the understanding of various research articles to identify research gap on a given topic **CO2:** Extract line of approach to overcome the research gap **CO3:** Conclude appropriate method/s suitablefor a given problem **CO4:** Identify characterization techniques/theoretical analysis for obtaining result **CO5:** Explain graphs, diagrams, flow chart etc. **CO6:** Report research findings in written andverbal forms	
7	Course Description	Reading in a field of special interest under the supervision of a faculty member. Intended for students interested in studying topics not offered in regularly available courses. Format and grading are determined by the supervising faculty member and the audit members then approved by the Head of Department.	
8	Outline		CO Achievement
	Part 1	**Introduction to various research problems**	**CO1**
	Part 2	**Identify a research question**	**CO2, CO3**
	Part 3	**Literature survey**	**CO4**/CO6
	Part 4	**Report writing**	**CO5**/CO6

Part 5	Presentation		CO6
Mode of Examination	7. Rubric assessment 8. Monthly Presentation to be audited by supervisor Mid Term Presentation and End TermPresentation		
Weightage	CA	CE	ESE	
	25	25	50	
Text book/s*	10 Recent International Journal Articles of repute.		

Course Articulation Matrix

Cos	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3
CO1	3	3	2	1	2	2	3	2	2	2	1	2	1	2
CO2	2	3	3	3	1	1	3	2	2	2	2	2	2	1
CO3	3	3	2	1	1	2	3	2	2	1	1	1	1	1
CO4	3	2	2	2	1	1	3	2	2	2	1	2	1	1
CO5	3	3	1	1	1	2	3	2	2	2	1	2	1	1
CO6	3	3	2	1	1	2	3	2	2	1	2	1	2	1

1-Slight (Low)   **2-Moderate (Medium)**   **3-Substantial (High)**

Industry Connect

	School: SSBSR	**Batch: 2023-2027**
	Programme: B.Sc.	**Current Academic Year:2025-2026**
	Branch: Environmental Sciences	**SEMESTER: V**
	Course Code	**INC001**
	Course Title	Industry Connect
	Credits	2
	Contact Hours(L-T-P)	0-0-4
	Course Status	Compulsory
	Course Objective	This course will expose students to apply theories learned in the classroom and providescurrent technological developments relevant to the subject area of training. Students will be able to identify the career preferences and professional goals.
	Course Outcomes	Students will be able to: CO1: Get familiarize with industry principles and practices. CO2: Identify and analyze an appropriate problem. CO3: Develop teamwork and apply prior acquired knowledge in problem solving. CO4: Demonstrate effective verbal and written communication skills. CO5: Practice scientists' responsibilities, self-understanding, self-discipline and ethicalstandards. CO6: Identify the career preferences and professional goals.
	Course Description	The Internship aims to offer students the opportunity to apply their prior acquired knowledge in problem solving. Students will acquire skills important for time management, discipline, self-learning, and effective communication and so on.
	Outline syllabus		**CO Mapping**
	Unit 1		
	A, B, C	Define objectives and conditions for the internship, ensuring students that itis related to the study path carried out at the University	CO1
	Unit 2		
	A, B, C	Problem Definition and identification, Team/Group formation and Project Assignment. Finalizing the problem statement, resource requirement, if any.	CO2
	Unit 3		
	A, B, C	The internship work plan is drawn up by developing team work and applies Prior acquired knowledge in problem solving.	CO3/CO6
	Unit 4		

A, B, C	Demonstrate and execute Project with the team. Submission of evaluationform and final report completed by the intern.	CO4/CO6
Unit 5		
A, B, C	Final evaluation form completed by the supervisor at the Host Organization and final presentation before departmental committee.	CO5/CO6
Mode of examination	Jury+Practical+Viva	
Weightage Distribution	CA	MSE	ESE
	25	25	75
Text book/s*		
Other References		

Course Articulation Matrix

Cos	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3
CO1	3	3	2	1	2	2	3	2	2	2	1	2	1	2
CO2	2	3	3	3	1	1	3	2	2	2	2	2	2	1
CO3	3	3	2	1	1	2	3	2	2	1	1	1	1	1
CO4	3	2	2	2	1	1	3	2	2	2	1	2	1	1
CO5	3	3	1	1	1	2	3	2	2	2	1	2	1	1
CO6	3	3	2	1	1	2	3	2	2	1	2	1	2	1

1-Slight (Low)   **2-Moderate (Medium)**   **3-Substantial (High)**

School: SSBSR	Batch: 2023-2027
Programme: B.Sc.	Current Academic Year: 2025-26
Branch: Environmental Sciences	SEMESTER:VI

1	Course Code	**BEN305**	
2	Course Title	**Energy and Environment**	
3	Credits	3	
4	Contact Hours (L-T-P)	3-0-0	
4	Course Status	Compulsory	
5	Max. Marks	15+10+75 = 100	
6	Min. Marks		
7	Course Objective	This course aims to provide students with a broad understanding of the existing energy resources, issues related to energy and the environment, challenges and possible paths to sustainable energy generation and use.	
8	Course Outcomes	CO1: Classify what is Renewable and non-renewable source of energy CO2: Ability to estimate the extent of pollution due to energy use CO3: Relate the energy generation and consumption with the environment CO4: Describes policies related to energy at national and international level CO5: Ability to demonstrate understanding of the global, regional and local initiatives for energy conservation and sustainable development CO6: Ability to apply energy resources knowledge in sustainable development	
9	Course Description	This course is designed to provide complESE understanding of energy resources	
10	Outline syllabus		CO Mapping
	Unit 1	**Energy Resources**	
	A	Defining energy; forms and importance; Global energy resources; renewable and non-renewable resources	CO1
	B	Distribution and availability; sources and sinks of energy;	CO1
	C	Past, present, and future technologies for capturing and integrating these resources into our energy infrastructure	CO1
	Unit 2	**Energy, Environment and Society**	

A	Nature, scope and analysis of local and global impacts of energy use on the environment	CO2
B	Fossil fuel burning and related issues of air pollution, greenhouse effect, global warming and, urban heat island effect	CO2
C	Nuclear energy and related issues such as radioactive waste, spent fuel; social inequalities related to energy production, distribution, and use	CO2
Unit 3	**Energy, Ecology and the Environment**	
A	Energy production as driver of environmental change; energy production,	CO3/ CO6
B	Global energy demand: historical and current perspective; energy demand and use in domestic, industrial, agriculture and transportation sector	CO3/ CO6
C	Transformation and utilization associated environmental impacts (Chernobyl and Fukushima nuclear accidents, construction of dams, environmental pollution)	CO3/ CO6
Unit 4	**Politics of Energy Policy**	
A	Energy over-consumption and its impact on the environment, economy, and global change	CO4/ CO6
B	Political choices in energy policy globally and in the Indian context (historical and contemporary case studies)	CO4/ CO6
C	Domestic and international energy policy; energy diplomacy and bilateral ties of India with her neighbors	CO4/ CO6
Unit 5	**Our Energy Future**	
A	Current and future energy use patterns in the world and in India; evolution of energy use over time	CO5/ CO6
B	Alternative sources as green energy (biofuels, wind energy, solar energy, geothermal energy; ocean energy; nuclear energy)	CO5/ CO6
C	Need for energy efficiency; energy conservation and sustainability; action strategies for sustainable energy mix and management from a future perspective	CO5/ CO6
Mode of examination	20 marks for Test / Quiz / Assignment / Seminar. 05 marks for Class Interaction	

Weightage Distribution	CA	MSE	ESE
	15	10	75

| Text book/s* | 1. Rowlands, I.H. 2009. Renewable Electricity: The Prospects for Innovation and Integration in Provincial Policies in Debora L. Van Nijnatten and Robert Boardman (eds), Canadian Environmental Policy and Politics: Prospects for Leadership and Innovation, Third Edition. Oxford University Press, pp. 167-82.
2. Oliver, J. 2013. Dispelling the Myths about Canada's Energy Future, Policy: Canadian Politics and Public Policy, June-July.
3. Mallon, K. 2006. Myths, Pitfalls and Oversights, Renewable Energy Policy and Politics: A Handbook for Decision-Making. Earth Scan. | |

Course Articulation Matrix

Cos	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO1	PSO2	PSO3
CO1	3	3	2	1	2	2	3	2	2	2	1	-	1	3
CO2	2	3	3	3	1	1	3	2	2	2	2	-	2	3
CO3	3	3	2	1	1	2	3	2	2	1	1	-	1	3
CO4	3	2	2	2	1	1	3	2	2	2	1	-	1	2
CO5	3	3	1	1	1	2	3	2	2	2	1	-	1	3
CO6	3	3	2	1	1	2	3	2	2	1	2	-	2	3

1-Slight (Low)   **2-Moderate (Medium)**   **3-Substantial (High)**

School: SSBSR	Batch: 2023-2027
Programme: B.Sc.	Current Academic Year: 2025-26
Branch: Environmental Sciences	SEMESTER:VI

1	Course Code	BEN306
2	Course Title	**Water Conservation**
3	Credits	5
4	Contact Hours (L-T-P)	5-0-0
4	Course Status	
5	Max. Marks	25+25+50 = 100
6	Min. Marks	
7	Course Objective	
8	Course Outcomes	CO1: Outline about wetland and watershed management CO2: Knowledge about rain water harvesting and rehabilitation of rivers CO3: Identify points of water loses and ways of water treatment CO4: Ability to make planned use of resources with involvement of Govt and non Govt bodies. CO5: Describe methods of water conservation in agriculture sector CO6: Knowledge about water conservation and management projectsincluding water harvesting, constructed wetlands and irrigation techniques.
9	Course Description	

10	Outline syllabus		CO Mapping
	Unit 1	**Wetland and Watershed Management**	
	A	Wetland and their management: Definition, types, ecologicalsignificance, threat to wetland.	CO1
	B	Wetland conservation and management: Ramsar convention andmajor wetland of India.	CO1
	C	Management of Watersheds, Recovery of Eutrophicated	CO1

		lakes	
	Unit 2	**Water Storage and Rehabilitation**	
A		Rehabilitation of polluted rivers: Ganga Action plan, Yamuna actionplan	CO2
B		Rain water harvesting, roof top rainwater harvesting, traditionaltechniques of rain water harvesting	CO2
C		Rainfall- run off relation, water storage in ponds, lakes, reservoirs and aquifers, groundwater recharge through wells, check dams and storage work.	CO2
Unit 3		**Water Losses and Industrial Water Conservation**	
A		Water losses: filtration, seepage and evaporation losses, pollution/ contamination of water quality due to agricultural practices i.e.,fertilizers and pesticides	CO3/ CO6
B		Self-purification of surface water, sources of agricultural waterpollution, pollutant dispersion in ground water	CO3/ CO6
C		Different methods to conserve water in industries: water recycling	CO3/ CO6
Unit 4		**Water Resource Management**	
A		Need of planned utilization of water resources, economics of waterresources utilization	CO4/ CO6
B		Flood plain zones management, modifying the flood, reducingsusceptibility to damage, reducing the impact of flooding	CO4/ CO6
C		Community involvement in water management, role of Panchayati raj, institutions, NGO's, media, political parties and farmers association	CO4/ CO6
Unit 5		**Water Conservation Methods in Agriculture**	
A		Different methods to conserve water in Agriculture, sprinkler, dripirrigation, root irrigation	CO5/ CO6
B		Use of polymers, organic amendments usage, dry land farming, agroforestry	CO5/ CO6
C		Cover crops growing, no till farming, orchard development, rotational crop method (alternate sowing method, alternate irrigation), water saving economic crops	CO5/ CO6
Mode of examination		20 marks for Test / Quiz / Assignment / Seminar.05 marks for Class Interaction	

Weightage Distribution	CA	MSE	ESE	
	15	10	75	

Course Articulation Matrix

Cos	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3
CO1	3	3	2	1	2	2	3	2	2	2	1	2	1	3
CO2	2	3	3	3	1	1	3	2	2	2	2	2	2	3
CO3	3	3	2	1	1	2	3	2	2	1	1	1	1	3
CO4	3	2	2	2	1	1	3	2	2	2	1	2	1	3
CO5	3	3	1	1	1	2	3	2	2	2	1	2	1	3
CO6	3	3	2	1	1	2	3	2	2	1	2	1	2	3

1-Slight (Low)   **2-Moderate (Medium)**   **3-Substantial (High)**

Urban Ecosystems

School: SSBSR	Batch: 2023-2027	
Programme: B.Sc.	Current Academic Year: 2026-2027	
Branch: Environmental Sciences	SEMESTER: VI	
1	Course Code	**BEN307**
2	Course Title	**Urban Ecosystems**
3	Credits	4
4	Contact Hours (L-T-P)	4-0-0
4	Course Status	Compulsory
5	Max. Marks	15+10+75 = 100
6	Min. Marks	
7	Course Objective	The paper is designed to enable the students to examine the existing environmentalissues, conflicts and their potential role in urban development.
8	Course Outcomes	CO1: Understanding of the major environmental and ecological preconditions andimpacts of urbanization. CO2: Analyze the extent of demand of infrastructure type according to locationCO3: Apply green technologies for sustainable development. CO4: Understanding the concept of green belt and green spaces in urban areas. CO5: Describe methods of land use planning and recommend appropriate designsfor environmental management. CO6: Discuss the impacts of built environment and concept of green technologiesfor sustainable development.
9	Course Description	It beholds importance as interaction between urban society and its environmenttranspires in governance and policy decisions.
10	Outline syllabus		CO Mapping
	Unit 1	**Environment in an urban setting**	
	A	Man as the driver of urban ecosystem; commodification of nature;metros, cities and towns as sources and sinks of	CO1

		resources	
		Resource consumption and its social, cultural, economic and ecological perspectives	CO1
	C	Urban transformation; increasing challenges posed by modernity forthe environment	CO1
Unit 2		**Urban Dwelling**	
	A	Urban Sprawl; Housing scenario across a range of large-medium-small cities	CO2
	B	Poverty and slums in an urban context; Town planning Acts and theirenvironmental aspects	CO2
	C	Energy consumption and waste disposal as well as accumulation;environmental costs of urban infrastructure	CO2
Unit 3		**Urban Interface with the Environment**	
	A	Definition and concepts: green technology, green energy, green infrastructure, green economy, and, green chemistry; sustainable consumption of resources	CO3/ CO6
	B	Individual and community level participation such as small-scale composting pits for biodegradable waste, energy conservation; Green technologies in historical and contemporary perspectives	CO3/ CO6
	C	Successful green technologies: wind turbines, solar panels; 3R's ofgreen technology: recycle, renew and reduce	CO3/ CO6
Unit 4		**Natural Spaces in a City**	
	A	Concept of 'controlled nature'; scope, importance and threats tonature in the city	CO4/ CO6
	B	Organization and planning of green spaces such as parks, gardensand public spaces	CO4/ CO6
	C	Concept of green belts; urban natural forest ecosystem as green lungs	CO4/ CO6
Unit 5		**Planning and Environmental Management**	
	A	Green buildings; history of green buildings, need and relevance ofgreen buildings over conventional buildings, construction of green buildings; associated costs and benefits; outlined examples of greenbuildings; LEED certified building	CO5/ CO6
	B	Eco-mark certification, establishment of Eco-mark in India, its importance and implementation; Green planning: role of governmental bodies, land use planning, concept of green cities, waste reduction and recycling in cities	CO5/ CO6
	C	Role of informal sector in waste management, public transportation for sustainable development, green belts.; rainwater harvesting (Corporation and Municipal areas)	CO5/ CO6

	Mode of examination	20 marks for Test / Quiz / Assignment / Seminar.05 marks for Class Interaction			
	Weightage Distribution	CA	MSE	ESE	
		15	10	75	
	Text book/s*	1. Ernstson, H. 2011. Re-translating nature in post-apartheid Cape Town: The material semiotics of people and plants at Bottom Road. In: Heeks, R., (Ed.) Conference on "Understanding Development through Actor-Network Theory", London School of Economics, 30 June, London. 2. Richter, M. & Weiland, U. (ed.). 2012. Applied Urban Ecology.Wiley-Blackwell, UK 3. Gaston, K.J. 2010. Urban Ecology. Cambridge University Press, New York. 4. Grimm, N. B., Faeth, S. H., et al. 2008. Global Change and the Ecology of Cities. Science 319: 756-760			

Course Articulation Matrix

Cos	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3
CO1	3	3	2	1	2	2	3	2	2	2	1	2	1	3
CO2	2	3	3	3	1	1	3	2	2	2	2	2	2	3
CO3	3	3	2	1	1	2	3	2	2	1	1	1	1	3
CO4	3	2	2	2	1	1	3	2	2	2	1	2	1	3
CO5	3	3	1	1	1	2	3	2	2	2	1	2	1	3
CO6	3	3	2	1	1	2	3	2	2	1	2	1	2	3

1-Slight (Low)   **2-Moderate (Medium)**   **3-Substantial (High)**

Multivariate Data Analysis

	School: SSBSR	Batch: 2023-27	
	Programme: B.Sc.	Academic Year: 2025-26	
	Branch: Environmental Sciences	Semester: VI	
1	Course Code	**BDA323**	
2	Course Title	**Multivariate Data Analysis**	
3	Credits	3	
4	Contact Hours(L-T-P)	3-0-0	
	Course Status	Minor / Elective	
5	Course Objective	Familiarise students with the multivariate normal distribution, estimation of the mean vector and the covariance matrix, the distributions and uses of sample correlation coefficients, classification of observations, the distribution of the sample covariance matrix, and the sample generalized variance.	
6	Course Outcomes	CO1: Demonstrate knowledge and understanding of the multivariate normal distribution. (K2, K3) CO2: Demonstrate knowledge and understanding of the concept of estimation of the mean vector and the covariance matrix. (K2, K3) CO3: Demonstrate advanced understanding of the concepts of dimension reduction technique. (K2, K3) CO4: Describe the concepts of how to use and apply dependence techniques in multivariate data analysis. (K2, K3) CO5: Describe the concepts of analysis of variance and covariance in multivariate data analysis. (K3, K4, K5) CO6: Apply the statistical tool and software in multivariate data analysis. (K2, K6)	
7	Course Description	This module aims to provide an understanding of the multivariate normal distribution, estimation of the mean vector and the covariance matrix, the distributions and uses of sample correlation coefficients, classification of observations, the distribution of the sample covariance matrix, and the sample generalized variance.	
8			
	Unit 1		
	A	A brief review of Univariate and Bivariate distribution with their properties.	CO1
	B	Basic Multivariate Distribution: mean, variance, Covariance, correlation, and the linear combination of variables.	CO1
	C	The multivariate normal distribution, Mean Vectors, and Covariance Matrices.	CO1
	Unit 2		
	A	Multivariate normal distribution; maximum likelihood estimation, Wishart's distribution	CO2
	B	Hotelling's T2 and hypothesis testing for multivariate normal data. Inference from a single sample, Inference from two dependent samples Inference from two independent samples.	CO2
	C	Simple, Multiple, Partial, and Canonical correlations with their properties.	CO2
	Unit 3		
	A	Principal Components Analysis and derivation of principal components; PCA structural model; PCA on normal populations; bi-plots.	CO3/CO6

B	Factor Analysis, Factor extraction Factor rotation, Factor scores Validation of factor analysis, Higher order factor analysis Q-type factor analysis	CO3, CO4/CO6
C	Cluster Analysis, Types of clustering, Correlation, and distance, Partitioning methods, hierarchical clustering, K-means clustering, and their interpretation.	CO4/CO6
Unit 4		
A	Simple, Multiple, and Multivariate regression with their properties.	CO5/CO6
B	Binary and multidimensional Logistic regression.	CO5/CO6
C	Linear discriminant function analysis. Estimating linear discriminant functions and their properties.	CO5/CO6
Unit 5		
A	Analysis of variance and covariance.	CO6
B	Multivariate analysis of variance and Covariance.	CO6
C	Concepts of correspondence analysis, chi-square distance and inertia, multiple correspondence analysis.	CO6
Mode of examination	Theory	
Weightage Distribution	CA: 15; MSE: 10; ESE:75	
Text book/s*	1. Johnson, R.A. and Wichern, D.W.: (2015). Applied Multivariate Statistical Analysis, Sixth Edition, Pearson Education India. 2. Hardle, W.K. and Hlavka, Z. (2015): Multivariate Statistics, Springer.	
Other References	1. Anderson, T.W. (2003): An Introduction to Multivariate Statistical Analysis, Third Edition, Wiley. 2. Härdle, W.K. and Simar, L. (2015): Applied Multivariate Statistical Analysis, Springer.	

Course Articulation Matrix

Cos	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3
CO1	3	1	2	-	1	-	-	-	-	-	-	-	-	-
CO2	3	1	2	-	1	-	-	-	-	-	-	-	-	-
CO3	3	1	2	-	1	-	-	-	-	-	-	-	-	-
CO4	3	1	2	-	1	-	-	-	-	-	-	-	-	-
CO5	3	1	2	-	1	-	-	-	-	-	-	-	-	-
CO6	3	1	2	-	1	-	-	-	-	-	-	-	-	-

1-Slight (Low)   **2-Moderate (Medium)**   **3-Substantial (High)**

Energy and Environment Lab

School: SSBSR	**Batch: 2023-2027**	
Programme: B.Sc.	**Current Academic Year: 2025-26**	
Branch: Environme ntalSciences	**SEMESTER:VI**	
1	Course Code	BEN352
2	Course Title	**Energy and Environment Lab**
3	Credits	2
4	Contact Hours (L-T-P)	0-0-4
4	Course Status	Compulsory
5	Max. Marks	25+25+50 = 100
6	Min. Marks	
7	Course Objective	This course aims to provide students with a broad understanding of the existing energy resources, issues related to energy and the environment, challenges and possible paths to sustainable energy generation and use.
8	Course Outcomes	CO1: Determination of energy efficiency of given data. CO2: Demonstration of water conservation techniques and Solar devices.CO3: Demonstration of biogas plant and wind mills. CO4: Explain energy plantation and watershed management.CO5: Analysis of Energy audit. CO6: Knowledge about Energy and water conservation techniques.
9	Course Description	This course is designed to provide complete understanding of energy resources.

10	Outline syllabus		CO Mapping
	Unit 1	**Energy Efficiency Calculation**	
	A	Determine energy efficiencies from the given data.	CO1
	B and C	Preparation of solar cooker model	CO1
	Unit 2	**Water Conservation Techniques**	
	A	Demonstration of water conservation techniques.	CO2

131

B and C	Demonstration of use of solar street lamping.			CO2
Unit 3	**Biogas Plant and Wind-Mill**			
A	Demonstration of Biogas plant			CO3/CO6
B and C	Demonstration of use of wind-mills.			CO3/CO6
Unit 4	**Energy Plantation and Watershed Management**			
A	Express the report on Energy Plantation			CO4/CO6
B and C	Explain water shed management project and field report preparation.			CO4/CO6
Unit 5	**Energy Audit**			
A	Analysis of Energy audit of a domestic unit/office.			CO5/CO6
B and C	Study of solar water pumping			
Mode of examination	20 marks for Test / Quiz / Assignment / Seminar.05 marks for Class Interaction			
Weightage Distribution	CA	MSE	ESE	
	25	25	50	
Text book/s*	1.Rowlands, I.H. 2009. Renewable Electricity: The Prospects for Innovation and Integration in Provincial Policies in Debora L. Van Nijnatten and Robert Boardman (eds), Canadian Environmental Policy and Politics: Prospects for Leadership and Innovation, Third Edition. Oxford University Press, pp. 167-82. 2. Oliver, J. 2013. Dispelling the Myths about Canada's Energy Future, Policy: Canadian Politics and Public Policy, June-July. Mallon, K. 2006. Myths, Pitfalls and Oversights, Renewable Energy Policy and Politics: A Handbook for Decision-Making. Earth Scan.			

Course Articulation Matrix

Cos	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3
CO1	3	3	2	1	2	2	3	2	2	2	1	2	1	2
CO2	2	3	3	3	1	1	3	2	2	2	2	2	2	3
CO3	3	3	2	1	1	2	3	2	2	1	1	1	1	2
CO4	3	2	2	2	1	1	3	2	2	2	1	2	1	2
CO5	3	3	1	1	1	2	3	2	2	2	1	2	1	1
CO6	3	3	2	1	1	2	3	2	2	1	2	1	2	2

1-Slight (Low)   **2-Moderate (Medium)**   **3-Substantial (High)**

Community Connect

SCHOOL: SSBSR		Batch: 2023-2027		
Programme: B.Sc.		Current Academic Year: 2025-26		
Branch: Environmental Sciences		Semester: VI		
1	**Course Number**	Course Code: CCU		
2	**Course Title**	**Community Connect**		
3	**Credits**	**2** **Course Status: Training/Survey/Project**		
4	**(L-T-P)**	**(0-0-3)**		
5	**Learning Hours**		Contact Hours	30	
			Project/Field Work	20	
			Assessment	00	
			Guided Study	10	
			Total hours	60	
6	**Course Objectives**	1. **Contribute to the holistic development of students** by making them more aware of socially and economically disadvantaged communities and their specific issues 2. **Provide more richer context to classrooms**, so as to make them more effective laboratories of learning by aligning them to social realities beyond textbooks 3. **Provide scope to faculty members to align their teaching and research goals** by giving them ample opportunity to carry out community -oriented projects 4. **Ensure that the community connect Programmes provides benefits to communities** in tangible ways so that they may feel perceptibly better off post the interaction and involvement of the Sharda academic community 5. **Provide ample opportunity for Sharda University academic community to contribute** effectively to society and nation building		
7	**Course Outcomes**	After completion of this course students will be able to: **CO1:** Students learn to be sensitive to the living challenges of disadvantaged communities. **CO2:** Students learn to appreciate societal realities beyond textbooks and classrooms **CO3:** Students learn to apply their knowledge via research, and trainingfor community benefit **CO4:** Students learn to work on socio-economic projects with teamwork and timely delivery **CO5:** Students learn to engage with communities for meaningful contribution to society		

8	**Theme**	**Major themes for research:**
		1. Survey and self-learning: In this mode, students will make survey, analyze data and will extract results out of it to correlate with their theoretical knowledge. E.g. Crops and animals, land holding, labour problems, medical problems of animals and humans, savage and sanitation situation, waste management etc. **2. Survey and solution providing**: In this mode, students will identify the common problems and will provide solution/ educate rural population. E.g. air and water pollution, need of after treatment, use of renewable (mainly solar) energy, electricity saving devices, inefficiencies in cropping system, animal husbandry, poultry, pest control, irrigation, machining in agriculture etc. **3. Survey and reporting**: In this mode students will educate villagers and survey the ground level status of various government schemes meant for rural development. The analyzed results will be reported to concerned agencies which will help them for taking necessary/corrective measures. E.g. Pradhan Mantri Jan Dhan Yojana, Pradhan Mantri MUDRA Yojana, Pradhan Mantri Jeevan Jyoti Bima Yojana, Atal pension Yojana, Pradhan Mantri Awas Yojana, Pradhan Mantri Fasal Bima Yojana, Swachh Bharat Abhiyan, Soil Health Card Scheme, Digital India, Skill India Programme,Beti Bachao, Beti Padhao Yojana, Deen Dayal Upadhyaya Gram Jyoti Yojana, Shyama Prasad Mukherjee Rurban Mission, UJWAL Discom Assurance Yojana, PAHAL Pradhan Mantri Awas Yojana-Gramin, Pradhan Mantri Yuva Yojana, Pradhan Mantri Jan Aushadhi Yojana, Pradhan Mantri KhanijKshetra Kalyan Yojana, Pradhan Mantri Suraksha Bima Yojana, UDAN scheme, Deen Dayal Upadhyaya Grameen Kaushalya Yojana, Pradhan Mantri Sukanya Samriddhi Yojana, Sansad Adarsh Gram Yojana, Pradhan Mantri Surakshit Matritva Abhiyan, Pradhan Mantri Rojgar Protsahan Yojana, Midday Meal Scheme, Pradhan Mantri Vaya Vandana Yojana, Pradhan Mantri MatritvaVandana Yojana, and Ayushman Bharat Yojana.
	Guidelines for Faculty Members	It will be a group assignment. There should be not more than 10 students in each group. The faculty guide will guide the students and approve the project title and help the student in preparing the questionnaire and final report. The questionnaire should be well design and it should carry at least 20 questions (Including demographic questions). The faculty will guide the student to prepare the PPT. The topic of the research should be related to social, economic or environmental issues concerning the common man. The report should contain 2,500 to 3,000 words and relevant charts, tables and photographs.

		Plagiarism check of the report must. ESE will conduct out of 100, divided in three parts (i) 30 Marks for report (ii) 30 Marks for presentation (iii) 40 Marks for knowledge. The student should **submit the report** to CCC-Coordinator signed by the faculty guide by ………………… The students have to send the hard copy of the **report and PPT**, and thenonly they will be allowed for ESE
	Role of CCC-Coordinator	The CCC Coordinator will supervise the whole process and assign students to faculty members. PG- M.Sc.-Semester II - the students will be allocated to faculty member (mentors/faculty member) in odd term.
	Layout of the Report	Abstract (250 words) <ol type="a"> - Introduction - Literature review(optional) - Objective of the research - Research Methodology - Finding and discussion - Conclusion and recommendation - References Note: Research report should base on primary data.
	Guideline for Report Writing	**Title Page: The following elements must be included:** - Title of the article; - Name(s) and initial(s) of author(s), preferably with first names spelled out; - Affiliation(s) of author(s); - Name of the faculty guide and Co-guide **Abstract:** Each article is to be preceded by a succinct abstract, of up to 250 words, that highlights the objectives, methods, results, and conclusions of the paper. **Text: Manuscripts should be submitted in Word.** - Use a normal, plain font (e.g., 12-point Times Roman) for text. - Use italics for emphasis. *Use the automatic page numbering function to number the pages.* *Save your file in docx format* (Word 2007 or higher) or doc format (older Word versions) Reference list: The list of references should only include works that are cited in the textand that have been published or accepted for publication. The entries in the list should be in alphabetical order.

Course Articulation Matrix

Cos	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3
CO1	3	3	2	1	2	2	3	2	2	2	1	2	1	2
CO2	2	3	3	3	1	1	3	2	2	2	2	2	2	3
CO3	3	3	2	1	1	2	3	2	2	1	1	1	1	2
CO4	3	2	2	2	1	1	3	2	2	2	1	2	1	2
CO5	3	3	1	1	1	2	3	2	2	2	1	2	1	1
CO6	3	3	2	1	1	2	3	2	2	1	2	1	2	2

1-Slight (Low)   **2-Moderate (Medium)**   **3-Substantial (High)**

Research Based Learning 4

School: SSBSR	Batch:2023-2027	
Programme: B.Sc.	Current Academic Year:2025-2026	
Branch:	Semester VI	
1	Course Code	RBL004	
2	Course Title	Research Based Learning 4	
3	Credits	1	
4	Contact Hours(L-T-P)	(0-0-2)	
	Course Status	Compulsory	
5	Course Objective	• Develop knowledge of a specific area ofspecialization. • Develop research skills especially inproject writing and oral presentation.	
6	Course Outcomes	**CO 1:** Reframe a research topic under study **CO 2:** Describe the research gap **CO 3:** Defend the best method to solve the problem **CO 4:** Categories and correlate the observation **CO 5:** Analyze observations and tabulate majorresearch findings. **CO 6:** Report research findings in written and verbalforms	
7	Course Description	Reading in a field of special interest under the supervision of a faculty member. Intended for studentsinterested in studying topics not offered in regularly available courses. Format and grading are determinedby the supervising faculty member and the audit Members then approved by the Head of Department.	
8	Outline		CO Achievement
	Part 1	**Introduction to various research problems**	**CO1**
	Part 2	**Identify a research question**	**CO2, CO3**
	Part 3	**Literature survey**	**CO4**/CO6
	Part 4	**Report writing**	**CO5**/CO6
	Part 5	**Presentation**	**CO6**

Mode of examination	Rubric assessment Monthly Presentation to be audited by supervisor Mid Term Presentation and End Term Presentation			
Weightage	CA	CE	ESE	
	25	25	50	
Text book/s*	10 Recent International Journal Articles of repute.			

Course Articulation Matrix

Cos	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3
CO1	3	3	2	1	2	2	3	2	2	2	1	2	1	1
CO2	2	3	3	3	1	1	3	2	2	2	2	2	2	3
CO3	3	3	2	1	1	2	3	2	2	1	1	1	1	1
CO4	3	2	2	2	1	1	3	2	2	2	1	2	1	2
CO5	3	3	1	1	1	2	3	2	2	2	1	2	1	1
CO6	3	3	2	1	1	2	3	2	2	1	2	1	2	1

1-Slight (Low)   **2-Moderate (Medium)**   **3-Substantial (High)**

Fourth Year
Detailed syllabus for
Bachelor (Honours)
In
Environmental Sciences

Natural Hazards and Disaster Management

School: SSBSR	Batch: 2023-2027	
Programme: B.Sc.	Current Academic Year: 2026-27	
Branch: Environmental Sciences	SEMESTER: VII	
1	Course Code	**BEN401**
2	Course Title	**Natural Hazards and Disaster Management**
3	Credits	3
4	Contact Hours (L-T-P)	3-0-0
4	Course Status	Compulsory
5	Max. Marks	15+10+75 = 100
6	Min. Marks	
7	Course Objective	This paper introduces the students to various aspects of environmental hazards, their causes, classifications, and impacts. It also focuses on the management strategies and governmental action plan to mitigate and prepare for such hazards.
8	Course Outcomes	CO1: Interpret the impact of Increasing population on occurrence of hazards CO2: Understand the geophysical processes as the drivers of different types of hazards CO3: Explain how human activities interface with the geophysical processes in causing and/or accentuating hazard. CO4: Identify the mitigation approaches, their choices and alternatives. CO5: Develop foundations for hazard, risk and vulnerability assessment CO6: Define natural and anthropogenic hazards with their management strategies and governmental actions.
9	Course Description	To increase the knowledge and understanding of the disaster phenomenon, its different contextual aspects, impacts and public health consequences.
10	Outline syllabus		CO Mapping
	Unit 1	**Introduction**	
	A	Definition of hazard; natural, technological, and context hazards; concept of risk and vulnerability	CO1
	B	Reasons of vulnerability - rapid population growth, urban expansion, environmental pollution	CO1

C	Epidemics, industrial accidents, inadequate government policies	CO1
Unit 2	**Natural hazards**	
A	Natural hazards: hydrological, atmospheric & geological hazards; earthquake: seismic waves, epicenter; volcanoes: causes of volcanism, geographic distribution	CO2
B	Floods: types and nature, frequency of flooding; landslides: causes and types of landslides, landslide analysis; drought: types of drought meteorological, agricultural, hydrological, and famine; Glacial Lake Outburst Floods (GLOF)	CO2
C	Tornadoes, cyclone & hurricanes; tsunamis: causes and location of tsunamis; coastal erosion, sea level changes and its impact on coastal areas and coastal zone management.	CO2
Unit 3	**Anthropogenic hazards**	
A	Impacts of anthropogenic activities such as rapid urbanization, injudicious ground water extraction, sand mining from river bank, deforestation	CO3/ CO6
B	Mangroves destruction; role of construction along river banks in elevating flood hazard; disturbing flood plains. deforestation and landslide hazards associated with it; large scale developmental projects, like dams and nuclear reactors in hazard prone zones	CO3/ CO6
C	Nature and impact of accidents, wildfires and biophysical hazards. Case studies of Bhopal, Minamata and Chernobyl disaster.	CO3/ CO6
Unit 4	**Risk and vulnerability assessment**	
A	Two components of risk: likelihood and consequences, qualitative likelihood measurement index; categories of consequences (direct losses, indirect losses, tangible losses, and intangible losses)	CO4/ CO6
B	Application of geoinformatics in hazard, risk & vulnerability assessment, Concept of mitigation; types of mitigation: structural and non-structural mitigation, use of technologies in mitigations such as barrier, deflection and retention systems; concept of preparedness	CO4/ CO6
C	Importance of planning, exercise, and training in preparedness; role of public, education and media in hazard preparedness	CO4/ CO6
Unit 5	**Disaster management in India**	
A	Lessons from the past considering the examples of Bhuj earthquake, tsunami disaster, and Bhopal tragedy	CO5/ CO6
B	National Disaster Management Framework, national response mechanism, role of government bodies such as NDMC and IMD; role of armed forces and media in disaster management	CO5/ CO6
C	Role of space technology in disaster management; case study of efficient disaster management during cyclone 'Phailin' in 2013	CO5/ CO6
Mode of examination	20 marks for Test / Quiz / Assignment / Seminar. 05 marks for Class Interaction	

	CA	MSE	ESE	
Weightage Distribution	CA	MSE	ESE	
	15	10	75	
Text book/s*	1. Cutter, S.L. 2012. Hazards Vulnerability and Environmental Justice. EarthScan, Routledge Press. 2. Schneid, T.D. & Collins, L. 2001. Disaster Management and Preparedness. Lewis Publishers, New York, NY. 3. Smith, K. 2001. Environmental Hazards: Assessing Risk and Reducing Disaster. Routledge Press. 4 Pine, J.C. 2009. Natural Hazards Analysis: Reducing the Impact of Disasters. CRC Press, Taylor and Francis Group.			

Course Articulation Matrix

Cos	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3
CO1	3	3	2	1	2	2	3	2	2	2	1	2	1	2
CO2	2	3	3	3	1	1	3	2	2	2	2	2	2	1
CO3	3	3	2	1	1	2	3	2	2	1	1	1	1	2
CO4	3	2	2	2	1	1	3	2	2	2	1	2	1	1
CO5	3	3	1	1	1	2	3	2	2	2	1	2	1	2
CO6	3	3	2	1	1	2	3	2	2	1	2	1	2	2

1-Slight (Low)   **2-Moderate (Medium)**   **3-Substantial (High)**

Remote Sensing & GIS

School: SSBSR	Batch: 2023-2027
Programme: B.Sc.	Current Academic Year: 2026-2027
Branch: Environmental Sciences	Semester: VII

1	Course Code	BEN402	
2	Course Title	Remote Sensing & GIS	
3	Credits	3	
4	Contact Hours (L-T-P)	3-0-0	
	Course Status	Compulsory	
5	Course Objective	1.Detailed understanding of principles of remote sensing 2. Understanding of concepts and various components of GIS alongwith its advantages and disadvantages 3: Provide a thorough concept on interpretation GIS database 4: Detailed understanding of Photogrammetry & Cartography 5: Application of remote sensing in natural hazards 6: Overall this course helps in-depth understanding of various components of remote sensing and application in the management ofnatural hazards.	
6	Course Outcomes	CO1: To Define and Describe the concept of remote sensing and principle behind the same. CO2: Explain the Principles of GIS CO3: Identify the Use GIS and its different components forapplication in case studies CO4: Discover the concept of Photogrammetry & Cartography CO5: Determine the Remote Sensing Application in natural hazards CO6: design and develop the Overall understanding of various components of remote sensing and application natural hazards management.	
7	Course Description	To develop an understanding of geo informatics, its principle, tools and techniques and application different fields of environmental science	
8	Outline syllabus		CO Mapping
	Unit 1	Principles of remote Sensing	

	A	Electromagnetic Radiation and Electromagnetic Spectrum, Interaction with the Atmosphere and radiation target	CO1
	B	Passive & Active Remote Sensing, Aerial Photographs and Satellite based Remote Sensing, Digital Image Processing and Interpretation	CO1
	C	Platforms and RS Data Acquisition Systems, Microwave Thermal Remote Sensing	CO1
Unit 2		**Principles of GIS**	
	A	Basic Concepts: definition and component of GIS,	CO2
	B	Areas of GIS application, GIS Data and Data Structures.	CO2
	C	Advantage and Limitation of GIS	CO2
Unit 3		**GIS Database**	
	A	Creating GIS Database-GIS Software, file organization and formats	CO3/CO6
	B	Method of spatial data capture	CO3/CO6
	C	Editing of data	CO3/CO6
Unit 4		**Photogrammetry & Cartography**	
	A	Classification of aerial photographs. Scale of aerial photographs on uniform and variable terrain.	CO4/CO6
	B	History and evolution of 2D and 3D imaging systems on Indian and foreign satellites Epi-polar registration of stereo images, Digital feature extraction and matching techniques for stereo image analysis.	CO4/CO6
	C	Use of GPS and SAR interferometry data in 3D mapping, Cartographic problems of mapping the earth with horizontal and vertical controls, Reference Surfaces, Geoid and ellipsoid definitions, Map Projections and their properties, Hardware and software components of digital mapping systems.	CO4/CO6
Unit 5		**Application of Remote Sensing in Natural Hazards**	
	A	Natural hazards: Concept of natural hazard. Types and classification of natural hazards: Causes, effects,	CO5/CO6

B	Monitoring, management of Earthquakes, Volcanic eruptions, Tsunamis.			CO5/CO6
C	Role of remote sensing in monitoring and damage assessment.			CO5/CO6
Mode of examination	Theory			
Weightage Distribution	CA	MSE	ESE	
	15	10	75	
Text book/s*	1. Asrar Ghassem Theory and applications of optical remote sensing New York: John Wileyand Sons. 2. Campbell J.B. (2002) Introduction to Remote Sensing, 3rd ed., The Guilford Press. 3. Curran P.J., Principles of Remote Sensing, UK, ELBS.			

Course Articulation Matrix

Cos	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3
CO1	3	3	2	1	2	2	3	2	2	2	1	2	1	2
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CO3	3	3	2	1	1	2	3	2	2	1	1	1	1	2
CO4	3	2	2	2	1	1	3	2	2	2	1	2	1	1
CO5	3	3	1	1	1	2	3	2	2	2	1	2	1	2
CO6	3	3	2	1	1	2	3	2	2	1	2	1	2	2

1-Slight (Low)   **2-Moderate (Medium)**   **3-Substantial (High)**

Bioinstrumentation

School: SSBSR	Batch: 2023-2227	
Programme: B.Sc.	Current Academic Year: 2026-2027	
Branch: Environmental Sciences	SEMESTER: VII	
1	Course Code	BEN403
2	Course Title	Bioinstrumentation
3	Credits	4
4	Contact Hours (L-T-P)	4-0-0
4	Course Status	Compulsory
5	Max. Marks	15+10+75 = 100
6	Min. Marks	
7	Course Objective	This course provides an opportunity to develop knowledge and understanding of the basic concepts of bioinstrumentations
8	Course Outcomes	CO1: To define and understand the concept and principle of microscopy CO2: To understand and explain brief idea about common biotech lab instrument CO3: To identify the principle of centrifugation and different types of centrifuge CO4: To analysis the basic principle of chromatography and discuss different types of chromatographic techniques CO5: To explain different types of electrophoresis and understand the principle of PCR and DNA sequencing CO6: To develop the various radio isotopic techniques
9	Course Description	This course provides students a full exposure to the basic principles and essential concepts of bioinstrumentation.

10	Outline syllabus		CO Mapping
	Unit 1	**Common Instruments Usage and Principle**	
	A	pH meter, Weighing balances	CO1
	B	Usage and applications of horizontal and vertical autoclave	CO1
	Unit 2	**Microscopy**	

A	Simple, phase contrast, bright and dark field microscopyConfocal and super resolution microscopy		CO2
B	Fluorescence and Electron microscopy (TEM and SEM)		CO2, CO6
C	Principle of centrifugation, different types of centrifuge androtors, Types of rotor: fixed angle and swinging bucket rotors,		CO2, CO6
Unit 3	**Chromatographic techniques**		
A	Liquid, column, and affinity chromatography		
B	Thin layer and gel-filtration chromatography		CO3/CO6
C	Ion exchange and hydrophobic chromatography		CO3, CO6
Unit 4	**Radioisotopic Techniques**		
A	Principles and application of tracer techniques in biology, radioactive isotopes.		CO4/CO6
B	Half-life of isotopes, Cerenkov radiation, liquid scintillation, GM counter.		CO4, CO6
C	Effect of radiation on biological system, radioactive labeling of biological macromolecules, autoradiography and radiation dosimetry		CO4, CO6
Unit 5	**Spectroscopy**		
A	Spectroscopy-II and Thermal Analysis: Principles, Instrumentation & applications for flame emission / atomic absorption spectrophotometry and their comparative study		CO5, CO6
B	Mass spectrometry; Principles, Instrumentation and applications		CO5/CO6
C	Differential scanning calorimetry and Thermogravimetric		CO5, CO6
Mode of examination	20 marks for Test / Quiz / Assignment / Seminar.05 marks for Class Interaction		
Weightage Distribution	CA	MSE	ESE
	15	10	75
Text book/s*	Soil and Water Conservation Engineering.DKSGACA Manual No. 03/2021. A Laboratory Manual. Prepared by. Dr. Mahesh Prasad Tripathi.		

Course Articulation Matrix

Cos	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3
CO1	3	3	2	1	2	2	3	2	2	2	1	-	-	2
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CO3	3	3	2	1	1	2	3	2	2	1	1	-	-	1
CO4	3	2	2	2	1	1	3	2	2	2	1	-	-	1
CO5	3	3	1	1	1	2	3	2	2	2	1	-	-	1
CO6	3	3	2	1	1	2	3	2	2	1	2	-	-	1

1-Slight (Low)　　　　**2-Moderate (Medium)**　　　　**3-Substantial (High)**

Solid Waste Management

School: SSBSR	Batch: 2023-2027	
Programme: B.Sc.	**Current Academic Year: 2026-2027**	
Branch: Environmental Sciences	**SEMESTER: VII**	
1	Course Code	**BEN404**
2	Course Title	**Solid Waste Management**
3	Credits	4
4	Contact Hours (L-T-P)	4-0-0
4	Course Status	Compulsory
5	Max. Marks	15+10+75 = 100
6	Min. Marks	
7	Course Objective	To deal with solid waste generation, management and to minimize its effects on environment.
8	Course Outcomes	CO1: Explain the concept of solid waste management and its impacts on environment. CO2: understanding on various technological applications for processing of waste and their disposals in various ways. CO3: explain the hierarchical structure in solid waste management and requirement for an integrated solution. CO4: Conclude the recent trends in reuse of solid waste CO5: Describe the components of solid waste management and the law governing it. CO6: understand the implications of the production, resource management and environmental impact of solid waste management.
9	Course Description	This paper throws light on the current scenario of solid waste generation and problem in its handling and management. It deals with the different governmental policies that explain proper transportation, handling and disposal of solid waste to minimize its effect on environment.
10	Outline syllabus	CO Mapping

Unit 1		Solid Waste	
A		Sources and generation of solid waste; their classification and chemical composition; characterization of municipal solid waste	CO1
B		Hazardous waste and biomedical waste, Impact of solid waste onenvironment, human and plant health; water quality and aquatic life	CO1
C		mining waste and land degradation; effect of land fill leachate on soil characteristics and ground water pollution	CO1
Unit 2		Solid waste Management	
A		Different techniques used in collection, storage, transportation and disposal of solid waste (municipal, hazardous and biomedical waste)	CO2
B		Recycling, Composting, thermal treatment (pyrolysis and incineration) of waste material, Energy recovery options from organic wastes	CO2
C		landfill (traditional and sanitary landfill design), drawbacks in waste management techniques	CO2
Unit 3		Integrated waste management	
A		Concept of Integrated waste management; waste management hierarchy; methods and importance of Integrated waste management	CO3/CO6
B		Cradle-to-grave approach; lifecycle inventory of solid waste; role of life cycle assessment (LCA) in waste management	CO3/CO6
C		Advantage and limitation of LCA; case study on LCA of a product	CO3/CO6
Unit 4		Resource Recovery	
A		4R- reduce, reuse, recycle and recover; biological processing - composting, anaerobic digestion, aerobic treatment	CO4/CO6
B		Reductive dehalogenation; mechanical biological treatment; green techniques for waste treatment. Concept of waste-to-energy (WTE)	CO4/CO6
C		energy recovery from waste; refuse derived fuel (RDF); different WTE processes: combustion, pyrolysis	CO4/CO6
Unit 5		Policies for solid waste management	
A		Municipal Solid Wastes (Management and Handling) Rules 2000; Hazardous Wastes Management and Handling Rules 1989	CO5/CO6
B		Bio-Medical Waste (Management and Handling) Rules 1998, Fly ash Management Rules, (1999)	CO5/CO6

C	Plastic Waste (Management and Handling) Rules, 2011; E-Waste (Management) Rules, 2016	CO5/CO6
Mode of examination	20 marks for Test / Quiz / Assignment / Seminar.05 marks for Class Interaction	
Weightage Distribution	CA	MSE	ESE	
	15	10	75	
Text book/s*	1. Solid Waste Management Manual CPCB, New Delhi 2. Ecotechnology for Pollution Control and Environmental Management by Trivedy R.K. and Arvind Kumar Basic Environmental Technology Nathanson, J.A	

Course Articulation Matrix

Cos	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3
CO1	3	3	2	1	2	2	3	2	2	2	1	2	1	2
CO2	2	3	3	3	1	1	3	2	2	2	2	2	2	1
CO3	3	3	2	1	1	2	3	2	2	1	1	1	1	2
CO4	3	2	2	2	1	1	3	2	2	2	1	2	1	1
CO5	3	3	1	1	1	2	3	2	2	2	1	2	1	2
CO6	3	3	2	1	1	2	3	2	2	1	2	1	2	2

1-Slight (Low)   2-Moderate (Medium)   3-Substantial (High)

Non-Parametric Statistical Inference

School: SSBSR	**Batch: 2023-27**		
Programme: B.Sc.	**Academic Year: 2026-27**		
Branch: Environmental Sciences	**Semester: VII**		
1	Course Code	**MDA111**	
2	Course Title	**Non-Parametric Statistical Inference**	
3	Credits	4	
4	Contact Hours (L-T-P)	4-0-0	
	Course Status	Minor / Elective	
5	Course Objective	Familiarize students with basic concepts of non-parametric inference, nonparametric estimation, order statistics use, and application in real-life data.	
6	Course Outcomes	CO1: Explain the concept of non-parametric inference. (K2, K4) CO2: Apply the concept of nonparametric estimation and explain the completeness of the order statistic. (K3) CO3: Explain and use different non-parametric test estimators. (K2, K3, K4) CO4: Explain the properties of non-parametric test estimators. (K2, K4) CO5: Describe the concept of order statistics. (K1, K2) CO6: Understand and evaluate the application of non-parametric inference on real-life data. (K2, K6)	
7	Course Description	This course will cover the basic concepts of non-parametric inference, nonparametric estimation, order statistics use, and application in real-life data	
8			
	Unit 1		
	A	Non-Parametric methods, Advantages and Disadvantages,	CO1
	B	Uses and application of the non-parametric method,	CO1
	C	Type of non-parametric test,	CO1
	Unit 2		
	A	The sign test for paired data, One sample sign test,	CO2
	B	Ranked sum test, Mann-Whitney U test,	CO2
	C	Kruskalwali's test or H test,	CO2
	Unit 3		
	A	One sample run test, median test for randomness,	CO3/CO6
	B	Runs above and below the median, spearman rank correlation test	CO3, CO4/CO6
	C	Testing of hypothesis about rank correlation,	CO4/CO6
	Unit 4		
	A	Kolmogrov Smirnov test, Kendall test of Concordance	CO5/CO6
	B	Median test for two independent samples,	CO5/CO6

C	Wilcoxon Signed rank test, The Matched pairs sign, test	CO5/CO6
Unit 5		
A	Introduction and application of order statistics, Distribution of Single Order Statistics,	CO6
B	Joint distribution of two or more order statistics, Distribution of difference of two distinct order statistics.	CO6
C	Distribution of Range, Distribution of Quartile, and Distribution of median.	CO6
Mode of examination	Theory	
Weightage Distribution	CA: 15; MSE: 10; ESE: 75	
Text book/s*	1.Gibbons, J.D. & Chakraborti, S. (2010). Nonparametric Statistical Inference, 5th Edition. CRC Press. 2.Hollander, M., Wolfe, D. & Chicken, E. (2013). Nonparametric Statistical Methods, 3rd Edition. Wiley.	
Other References	3.Bonnini, S., Corain, L., Marozzi, M. & Salmaso, L. (2014). Nonparametric Hypothesis Testing Rank and Permutation Methods with Applications in R. Wiley. 4.Sprent, P. & Smeeton, N.C. (2013). Applied Nonparametric Statistical Methods, 4th Edition. CRC Press.	

Course Articulation Matrix

Cos	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3
CO1	3	1	2	-	1	-	-	-	-	-	-	-	-	-
CO2	3	1	2	-	1	-	-	-	-	-	-	-	-	-
CO3	3	1	2	-	1	-	-	-	-	-	-	-	-	-
CO4	3	1	2	-	1	-	-	-	-	-	-	-	-	-
CO5	3	1	2	-	1	-	-	-	-	-	-	-	-	-
CO6	3	1	2	-	1	-	-	-	-	-	-	-	-	-

1-Slight (Low)   **2-Moderate (Medium)**   **3-Substantial (High)**

Remote Sensing & GIS Lab

School: SSBSR		Batch: 2023-2027
Programme: B. Sc		Current Academic Year: 2026-2027
Branch: Environmental Sciences		Semester: VII
1	Course Code	**BEN451**
2	Course Title	**Remote Sensing & GIS Lab**
3	Credits	01
4	Contact Hours (L-T-P)	0-0-2
	Course Status	Compulsory
5	Course Objective	1. Provide an insight into various aspect of remote sensing 2. Enable students to do geo-referencing 3. Enable student to do layer staking 4. Students will get to know that how make maps of various locations 5. Enable student to do digitization 6. Overall students will develop skill in remote sensing.
6	Course Outcomes	CO1. Understanding Google Earth Data CO2. Understanding LANSAT Data CO3. Ability to download DEM Data CO4. Ability to georeferencing data CO5. Ability to compost data CO6. Overall understanding of various components of remote sensing.
7	Course Description	This course gives remote sensing exposure to the students.
	Unit 1	**Conversion of Data**
	A	Downloading Data from the Google Earth
	B and C	Converting KML file into Shape file
	Unit 2	**Data Downloading**

	A	Downloading Data from NRSC Bhuvan
	B and C	Downloading LANSAT Data from NRSC Bhuvan
	Unit 3	**Data Downloading**
	A	Downloading DEM Data from Earth Explorer
	B and C	Downloading STRM Data from Eart Explore
	Unit 4	**Georeferencing**
	A	Georeferencing downloaded toposheet
	B and C	Georeferencing downloaded map in JPEG
	Unit 5	**Map Making**
	A	Making Layout Map
	B and C	Map Composite
	Text book/s*	1. Asrar Ghassem Theory and applications of optical remote sensing New York: John Wiley and Sons. 2. Campbell J.B. (2002) Introduction to Remote Sensing, 3rd ed., The Guilford Press. 3. Curran P.J., Principles of Remote Sensing, UK, ELBS.

Course Articulation Matrix

Cos	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3
CO1	3	3	2	1	2	2	3	2	2	2	1	2	1	2
CO2	2	3	3	3	1	1	3	2	2	2	2	2	2	1
CO3	3	3	2	1	1	2	3	2	2	1	1	1	1	2
CO4	3	2	2	2	1	1	3	2	2	2	1	2	1	1
CO5	3	3	1	1	1	2	3	2	2	2	1	2	1	2
CO6	3	3	2	1	1	2	3	2	2	1	2	1	2	2

1-Slight (Low)   **2-Moderate (Medium)**   **3-Substantial (High)**

Environmental Impact and Risk Assessment

School: SSBSR	Batch: 2023-2027
Programme: B.Sc.	Current Academic Year: 2026-2027
Branch: Environmental Sciences	SEMESTER: VIII

1	Course Code	**BEN405**	
2	Course Title	**Environmental Impact and Risk Assessment**	
3	Credits	4	
4	Contact Hours (L-T-P)	4-0-0	
4	Course Status	Compulsory	
5	Max. Marks	15+10+75 = 100	
6	Min. Marks		
7	Course Objective	This course recognizes the growing need of industry to anticipate and incorporate environmental concerns and risks while developing large-scale projects.	
8	Course Outcomes	CO1: Explain the philosophies and historical development of EIA in India and elsewhere. CO2: understanding of the EIA process and the methodologies to prepare an EIS CO3: Identifies development actions with the fundamentals understanding of EIA and sustainable development. CO4: Understand the impacts of various industries CO5: Identify the characteristics and risk assessment CO6: Knowledge of tools and techniques to assess various environmental impacts and outlines various management options needed to mitigate these risks	
9	Course Description	The course emphasizes on the contemporary tools and techniques to assess various environmental impacts and outlines various management options need to mitigate these risks.	
10	Outline syllabus	CO Mapping	
	Unit 1	**Introduction**	
	A	Environmental impact assessment (EIA): definitions, introductionand concepts; rationale and historical development of EIA	CO1
	B	Environmental Assessment (SEA) – Principles and process; EIAnotification (MOEF) 1994, 2006	CO1

	C	Scope and methodologies of EIA; role of project proponents, Termsof Reference	CO1
Unit 2		**EIS Formation**	
	A	Impact Identification methods, impact prediction, models of prediction. Impact evaluation – Cost benefit analysis	CO2
	B	Acquisition of base line data, its importance, Mitigation of impacts – approaches	CO2
	C	Environmental Impact Statement (EIS), EnvironmentalManagement Plan (EMP)	CO2
Unit 3		**EIA monitoring and auditing**	
	A	Public participation in EIA, presentation and review process, methods and role of monitoring in EIA, Environmental auditing	CO3/CO6
	B	Rapid EIA; Strategic Environmental Assessment; Social ImpactAssessment	CO3/CO6
	C	Life cycle assessment; environmental appraisal; environmentalmanagement - principles, problems and strategies	CO3/CO6
Unit 4		**EIA and sustainable development**	
	A	Environmental planning; introduction to ISO and ISO 14000;sustainable development	CO4/CO6
	B	Status of EIA in India; current issues in EIA; case study of hydropower projects, thermal projects	CO4/CO6
	C	Environmental Impacts of mining industry, nuclear and thermalpower plant, textile industry, paper and pulp industry	CO4/CO6
Unit 5		**Risk assessment**	
	A	Risk assessment: introduction and scope; project planning; exposureassessment; toxicity assessment	CO5/CO6
	B	Hazard identification and assessment; risk characterization; riskcommunication; environmental monitoring	CO5/CO6
	C	Community involvement; legal and regulatory framework; humanand ecological risk assessment.	CO5/CO6
Mode of examination		20 marks for Test / Quiz / Assignment / Seminar.05 marks for Class Interaction	

Weightage Distribution	CA	MSE	ESE	
	15	10	75	
Text book/s*	1. Methods of Environmental Impact Assessment – Morris &Therivel 2. Environmental Impact Assessment – L.W. Canter 3. Chemical Principles of Environmental Pollution – Alloway &Ayers 4. Industrial Environment – Assessment and Strategy – S.K.Aggarwal			

Course Articulation Matrix

Cos	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3
CO1	3	3	2	1	2	2	3	2	2	2	1	2	1	2
CO2	2	3	3	3	1	1	3	2	2	2	2	2	2	1
CO3	3	3	2	1	1	2	3	2	2	1	1	1	1	2
CO4	3	2	2	2	1	1	3	2	2	2	1	2	1	1
CO5	3	3	1	1	1	2	3	2	2	2	1	2	1	2
CO6	3	3	2	1	1	2	3	2	2	1	2	1	2	2

1-Slight (Low)   **2-Moderate (Medium)**   **3-Substantial (High)**

School: SSBSR	Batch: 2023-2027
Programme: B.Sc.	**Current Academic Year: 2026-27**
Branch: Environmenta lSciences	**SEMESTER: VIII**

1	Course Code	**BEN 406**	
2	Course Title	**Environmental Biotechnology**	
3	Credits	4	
4	Contact Hours (L-T-P)	4-0-0	
4	Course Status	Compulsory	
5	Max. Marks	15+10+75= 100	
6	Min. Marks		
7	Course Objective	Application of biotechnological know-hows in tackling environmental problems.	
8	Course Outcomes	CO1: Describe Structure and Function of DNA, RNA and Protein CO2: Understand genetic materials in prokaryotes and Eukaryotes CO3: Understand the concept of recombinant DNA technology and genomic library CO4: Interpret fundamental concepts of environmental biotechnology, highlighting the importance of microbial ecology. CO5: Explain how modern biotechnology is developed to achieve better environmental protection and sustainability through the use of microbes and microbial communities in pollution abatement CO6: Knowledge about molecular biology and its applications in ecological restoration	
9	Course Description	Knowledge about molecular biology and later links to application-based processes and techniques.	
10	Outline syllabus		CO Mapping
	Unit 1	**The Structure and Function of DNA, RNA and Protein**	
	A	DNA: structural forms and their characteristics (B, A, C, D, T, Z); physical properties: UV absorption spectra, denaturation and renaturation kinetics; biological significance of different forms; Synthesis.	CO1
	B	RNA: structural forms and their characteristics (rRNA, mRNA, tRNA; SnRNA, Si RNA, miRNA, hnRNA); biological significance of different types of RNA; synthesis.	CO1
	C	Protein: hierarchical structure (primary, secondary, tertiary, quaternary), types of amino acids; posttranslational modifications and their significance; synthesis; types and their role: structural, functional (enzymes).	CO1

Unit 2	**Prokaryotes and Eukaryotes**	
A	Central dogma of biology; genetic material prokaryotes, viruses,	CO2
B	Genetic material eukaryotes and organelles; mobile DNA	CO2
C	Chromosomal organization (euchromatin, heterochromatin - constitutive and facultative heterochromatin)	CO2
Unit 3	**Recombinant DNA Technology**	
A	Recombinant DNA: origin and current status; steps of preparation; toolkit of enzymes for manipulation of DNA	CO3/ CO6
B	Restriction enzymes, polymerases (DNA/RNA polymerases, transferase, reverse transcriptase), other DNA modifying enzymes (nucleases, ligase, phosphatases, polynucleotide kinase)	CO3/ CO6
C	Genomic and cDNA libraries: construction, screening and uses; cloning and expression vectors (plasmids, bacteriophage, phagmids, cosmids, artificial chromosomes; nucleic acid microarrays	CO3/ CO6
Unit 4	**Ecological restoration and bioremediation**	
A	Wastewater treatment: anaerobic, aerobic process, methanogenesis, bioreactors, cell and protein (enzyme) immobilization techniques; treatment schemes for waste water: dairy, distillery, tannery, sugar, antibiotic industries	CO4/ CO6
B	Solid waste treatment: sources and management (composting, vermiculture and methane production, landfill. hazardous waste treatment	CO4/ CO6
C	Constructed wetlands, use of bioreactors for bioremediation; phytoremediation; remediation of degraded ecosystems; advantages and disadvantages	CO4/ CO6
Unit 5	**Ecologically safe products and processes**	
A	PGPR bacteria: biofertilizers, microbial insecticides and pesticides, bio-control of plant pathogen, Integrated pest management	CO5/ CO6

B	Development of stress tolerant plants, biofuel; mining and metal biotechnology: microbial transformation	CO5/ CO6
C	Accumulation and concentration of metals, metal leaching, extraction; exploitation of microbes in copper and uraniumextraction	CO5/ CO6
Mode of examination	20 marks for Test / Quiz / Assignment / Seminar. 05 marks for Class Interaction	

Weightage Distribution	CA	MSE	ESE	
	15	10	75	

Course Articulation Matrix

Cos	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3	PSO 4
CO1	3	3	2	1	2	2	3	2	2	2	1	2	1	2	3
CO2	2	3	3	3	1	1	3	2	2	2	2	2	2	1	3
CO3	3	3	2	1	1	2	3	2	2	1	1	1	1	2	3
CO4	3	2	2	2	1	1	3	2	2	2	1	2	1	1	3
CO5	3	3	1	1	1	2	3	2	2	2	1	2	1	2	3
CO6	3	3	2	1	1	2	3	2	2	1	2	1	2	2	3

1-Slight (Low)   **2-Moderate (Medium)**   **3-Substantial (High)**

Environmental Toxicology

School: SSBSR	Batch:2023-2027
Programme: B.Sc.	Current Academic Year: 2026-2027
Branch: Environmental Sciences	SEMESTER: VIII

1	Course Code	BEN 407	
2	Course Title	Environmental Toxicology	
3	Credits	4	
4	Contact Hours (L-T-P)	4-0-0	
4	Course Status	Compulsory	
5	Max. Marks	15+10+75 = 100	
6	Min. Marks		
7	Course Objective	It provides knowledge of chemical properties of different groups of compounds and biological effects and important cycles, as basis for a comprehensive understanding of climate/environment, pollution and toxicology.	
8	Course Outcomes	CO1: Describe the most relevant terms, principles, and methods in environment toxicology. CO2: Explain the impacts of toxic chemicals on human health. CO3: Knowledge about various toxic chemicals and their mode of entry in ecosystem CO4: Identify water born transmissible diseases. CO5: Understanding the impacts of toxic chemicals at genetic level. CO6: Evaluate and apply concepts from multiple sub-disciplines in environment chemistry and toxicology.	
9	Course Description	It includes the fundamental concepts of toxicology, which include dose-response exposure routes, biological variation, and toxicity phases.	
10	Outline syllabus		CO Mapping
	Unit 1	**Introduction**	
	A	Toxic Chemical in the Environment: Metals and other inorganic contaminants; Organic contaminants; Fate of organic contaminants	CO1
	B	Pesticides; Biochemical aspects of Arsenic, cadmium, lead, mercury	CO1

C		Biochemical aspects of Selenium, carbon monoxide, ozone and PAN	CO1
Unit 2	**Pollution and human health**		
A		Pesticides; Insecticides, MIC, Photochemistry of Brominated FlameRetardants (BFR)	CO2
B		Trace element deficiency and disorders, occupational health hazards	CO2
C		Biogeochemical factors in environmental health, epidemiologicalissues goiter, fluorosis, arsenic poisoning.	CO2
Unit 3	**Principles of toxicology**		
A		Toxic chemicals in the environment and their effects, heavy metals- -Pb, CD, Hg	CO3/ CO6
B		Pesticides - DDT, HCH, eldrin, dieldrin, malathion, carbaryl.	CO3/ CO6
C		Mode of entry of toxic substances, biotransformation of xenobioticsdetoxification, indices of toxicology	CO3/ CO6
Unit 4	**Transmissible diseases**		
A		Symptoms, epidemiology and control of vector borne diseasesamoebiasis, trypanosomiasis	CO4/ CO6
B		Filariasis, leishmaniasis, schistosomiasis, life cycle of Plasmodium,control of Malaria	CO4/ CO6
C		Tuberculosis and AIDS. Waterborne diseases: Jaundice & diarrhea	CO4/ CO6
Unit 5	**Genetic Toxicology**		
A		Mutagens, teratogens, teratogenesis and teratology testing, Environmental mutagen testing- Bacterial mutagenesis assays	CO5/ CO6
B		Gene mutation and chromosome damage assays, DNA damage and repair assays, Strategies for protection of man from toxicants. Monoclonal antibody technology (hybridoma), Elisa	CO5/ CO6
C		Carcinogens, chemical carcinogenicity, mechanism of carcinogenicity, molecular toxicology and genetic basis of carcinogenesis- oncogenes and their mode of action, tumour suppressor genes. Model of oncogenesis, Environmental carcinogenicity testing	CO5/ CO6

Mode of examination	10 marks for Test / Quiz / Assignment / Seminar.05 marks for Class Interaction		
Weightage Distribution	CA	MSE	ESE
	15	10	75
Text book/s*	Gaston, K J. & Spicer, J.I. 1998. Biodiversity: An Introduction. Blackwell Science, London, UK. Krishnamurthy, K.V. 2004. An Advanced Text Book of Biodiversity - Principles and Practices. Oxford and IBH PublicationsCo. Pvt. Ltd. New Delhi. Primack, R.B. 2002. Essentials of Conservation Biology (3rd edition). Sinauer Associates, Sunderland, USA.		

Course Articulation Matrix

Cos	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3
CO1	3	3	2	1	2	2	3	2	2	2	1	2	1	2
CO2	2	3	3	3	1	1	3	2	2	2	2	2	2	1
CO3	3	3	2	1	1	2	3	2	2	1	1	1	1	2
CO4	3	2	2	2	1	1	3	2	2	2	1	2	1	1
CO5	3	3	1	1	1	2	3	2	2	2	1	2	1	2
CO6	3	3	2	1	1	2	3	2	2	1	2	1	2	2

1-Slight (Low)   **2-Moderate (Medium)**   **3-Substantial (High)**

Renewable Energy Resources

School: SSBSR	Batch: 2023-2027	
Programme: B.Sc.	Current Academic Year: 2026-2027	
Branch: Environmental Sciences	SEMESTER: VIII	
1	Course Code	BEN408
2	Course Title	**Renewable Energy Resources**
3	Credits	4
4	Contact Hours (L-T-P)	4-0-0
4	Course Status	Compulsory
5	Max. Marks	15+10+75 = 100
6	Min. Marks	
7	Course Objective	To know the availability and applications of Renewable energy resources.
8	Course Outcomes	CO1: Understand the need of renewable energy sources in present scenario. CO2: Explain the field applications of solar energy. CO3: Identify Winds energy and Tidal energy as alternate form of energy and to know how it can be tapped. CO4:Understand the Geothermal & Hydro energy, its mechanism of production and it applications. CO5: Describe hydrogen energy, its mechanism of production and its applications. CO6:Conceptual understanding of technical and commercial aspects of Alternative Sources of Energy.
9	Course Description	This course envisages the new and renewable source of energy, available in nature and to expos the students on sources of energy crisis and the alternates available.

10	Outline syllabus	CO Mapping
	Unit 1	**Fossil fuels and Alternate Sources of Energy**	
	A	Fossil fuels and nuclear energy, their limitation, need of renewable energy, non- conventional energy sources	CO1
	B	An overview of developments in Offshore Wind Energy, Tidal Energy, Wave energy systems, Ocean Thermal Energy Conversion, solar energy, biomass, biochemical	CO1

		conversion, biogas generation	
	C	Geothermal energy tidal energy, Hydroelectricity. Environmental issues and Renewable sources of energy	CO1
Unit 2		**Solar Energy**	
	A	Solar energy, its importance, storage of solar energy, solar pond, applications of solar pond and solar energy	CO2
	B	Solar thermal conversion; Solar water heater, flat plate collector, solar distillation, solar cooker, solar green houses, Solar thermal power generation	CO2
	C	Solar photovoltaic conversion; Basic Principle of SPV conversion – Types of PV Systems- Types of Solar Cells, Applications	CO2
Unit 3		**Wind and Ocean Energy**	
	A	Fundamentals of Wind energy, Wind Turbines and different electrical machines in wind turbines	CO3/ CO6
	B	Ocean Energy: Ocean Energy Potential against Wind and Solar, Wave Characteristics and Statistics, Wave Energy Devices	CO3/ CO6
	C	Tide characteristics, Tide Energy Technologies, Ocean Thermal Energy, Osmotic Power, Ocean Bio-mass	CO3/ CO6
Unit 4		**Geothermal and Hydro energy**	
	A	Geothermal Energy: Geothermal Resources, Geothermal Technologies	CO4/ CO6
	B	Hydro-Energy: Hydropower resources, hydropower technologies	CO4/ CO6
	C	Environmental impact of hydro power sources.	CO4/ CO6
Unit 5		**Hydrogen Energy**	
	A	Introduction to hydrogen energy, production, hydrogen from fossil fuels, electrolysis of water	CO5/ CO6
	B	Hydrogen fuel cells, Concept, key components, physical and chemical phenomena in fuel cells, advantages and disadvantages	CO5/ CO6
	C	Hydrogen Utilization for various applications including sectors like transportation, energy storage, industrial applications	CO5/ CO6
Mode of examination		20 marks for Test / Quiz / Assignment / Seminar. 05 marks for Class Interaction	
Weightage Distribution	CA	MSE	ESE
	15	10	75
Text book/s*	1. Groom. B. & Jenkins. M. 2000.Global Biodiversity: Earth's Living Resources in the 21st Century. World	

Conservation Press, Cambridge, UK.
2. Gurevitch, J., Scheiner, S. M., & Fox, G. A. 2002.
The Ecology of Plants. Sinauer associates incorporated.
3. Loreau, M. & Inchausti, P. 2002. Biodiversity and
Ecosystem functioning: Synthesis and Perspectives.
Oxford University Press, Oxford, UK.
4. Pandit, M.K., White, S.M.& Pocock, M.J.O. 2014.
The contrasting effects of genome size, chromosome
number and ploidy level on plant invasiveness: a global
analysis. New Phytologist 203: 697-703.

Course Articulation Matrix

Cos	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3
CO1	3	3	2	1	2	2	3	2	2	2	1	2	1	2
CO2	2	3	3	3	1	1	3	2	2	2	2	2	2	1
CO3	3	3	2	1	1	2	3	2	2	1	1	1	1	2
CO4	3	2	2	2	1	1	3	2	2	2	1	2	1	1
CO5	3	3	1	1	1	2	3	2	2	2	1	2	1	2
CO6	3	3	2	1	1	2	3	2	2	1	2	1	2	2

1-Slight (Low)   **2-Moderate (Medium)**   **3-Substantial (High)**

Sampling Theory

School: SSBSR	Batch: 2023-27	
Programme: B.Sc.	Academic Year: 2026-27	
Branch: Environmental Sciences	Semester: VIII	
1	Course Code	**BDA214**
2	Course Title	**Sampling Theory**
3	Credits	4
4	Contact Hours(L-T-P)	4-0-0
	Course Status	Minor / Elective
5	Course Objective	To make students familiar with the concept of sample and population, complete enumeration versus sampling. The concept of Systematic Sampling, estimates of the population mean and total, variances of these estimates along with the brief of the present official statistical system in India, methods of collection of official statistics, their reliability, and limitations have been introduced.
6	Course Outcomes	CO1: Explain and illustrate the concepts of sample and population. (K2, K3, K4) CO2: Describe the properties of complete enumeration versus sampling; explain random sampling with and without replacement. (K1, K2, K3) CO3: Describe estimates of the population mean, explain its application and estimates of these variances, and sample size determination. (K2, K3, K4) CO4: Describe stratified random sampling, estimates of the population mean and total and explain its application, and illustrate systematic sampling. (K2, K3, K4) CO5: Describe the ratio and regression methods of estimation and evaluate variances in terms of the correlation coefficient between X and Y for the regression method and their comparison with SRS. (K2, K3, K6) CO6: Describe and analyze the basic concepts present official statistical system in India, and methods of collection of official statistics. (K1, K2, K4)
7	Course Description	This course initiates the advanced concept of sample and population, complete enumeration versus sampling. The concept of Systematic Sampling, estimates of the population mean and total, variances of these estimates along with the brief of the present official statistical system in India, methods of collection of official statistics, their reliability, and limitations have been introduced.
8			
	Unit 1		
	A	Concept of sample and population, complete enumeration versus sampling	CO1
	B	Sampling and non-sampling errors, requirements of a good sample,	CO1
	C	Simple random sampling with and without replacement.	CO2
	Unit 2		
	A	Estimates of the population mean, total, and proportion,	CO3
	B	Variances of these estimates	CO3
	C	Estimates of theses variances and sample size determination.	CO3
	Unit 3		

A	Stratified random sampling, estimates of the population mean, and total variances of these estimates.	CO4
B	Proportional and optimum allocations and their comparison with SRS.	CO4
C	Systematic Sampling, estimates of the population mean and total, variances of these estimates.	CO4
Unit 4		
A	Ratio and regression methods of estimation, estimates of the population mean and total (for SRS of large size),	CO5
B	Variances of these estimates and estimates of theses variances,	CO5
C	Variances in terms of the correlation coefficient between X and Y for regression method and their comparison with SRS.	CO5
Unit 5		
A	Present official statistical system in India, Methods of collection of official statistics, their reliability and limitations.	CO6
B	Principal publications containing data on the topics such as population, industry, and finance.	CO6
C	Various official agencies are responsible for data collection and their main functions.	CO6
Mode of examination	Theory	
Weightage Distribution	CA: 25%; MTE: 25%; ETE:50%	
Text book/s*	1. Goon A.M., Gupta M.K. and Dasgupta B (2001): Fundamentals of Statistics (Vol.2), Word Press. 2. Murthy M.N. (1977): Sampling Theory & Statistical Methods, Statistical Pub. Society, Calcutta 3. Des Raj and Chandhok P.(1998): Sample Survey Theory, Narosa Publishing House. 4. Cochran W.G (1984): Sampling Techniques (3rd Ed.), Wiley Eastern.	
Other References	1. Mukhopadhyay P. (1998): Theory and Methods of Survey Sampling, Prentice Hall 2. Sampat S. (2001): Sampling Theory and Methods, Narosa Publishing House 3. Guide to current Indian Official Statistics, Central Statistical Organization, GOI, New Delhi. 4. Saluja, M.P. (1972): Indian official statistical systems, Statistical Pub. Society, Calcutta.	

Course Articulation Matrix

Cos	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3
CO1	3	1	2	-	1	-	-	-	-	-	-	-	-	-
CO2	3	1	2	-	1	-	-	-	-	-	-	-	-	-
CO3	3	1	2	-	1	-	-	-	-	-	-	-	-	-
CO4	3	1	2	-	1	-	-	-	-	-	-	-	-	-
CO5	3	1	2	-	1	-	-	-	-	-	-	-	-	-

CO6	3	1	2	-	1	-	-	-	-	-	-	-	-	-

1-Slight (Low)   **2-Moderate (Medium)**   **3-Substantial (High)**

Fourth Year
Detailed syllabus for
Bachelor (honours with research)
In
Environmental Sciences

School: SSBSR	Batch: 2023-2027	
Programme: B. Sc.	Current Academic Year: 2026-27	
Branch: Environmental Sciences	Semester VII	
1 Course Code	BEN452	
2 Course Title	Project	
3 Credits	3	
4 Contact Hours(L-T-P)	(0-0-6)	
Course Status	Compulsory	
5 Course Objective	• Develop knowledge of a specific area of specialization. • Develop research skills especially in project writing and oral presentation.	
6 Course Outcomes	**CO 1:** Reframe a research topic under study **CO 2:** Describe the research gap **CO 3:** Defend the best method to solve the problem **CO 4:** Categories and corelate the observation **CO 5:** Analyze observations and tabulate major research findings. **CO 6:** Report research findings in written and verbal forms	
7 Course Description	Reading in a field of special interest under the supervision of a faculty member. Intended for students interested in studying topics not offered in regularly available courses. Format and grading are determined by the supervising faculty member and the audit members then approved by the Head of Department.	
8 Outline		CO Achievement
Part 1	**Introduction to various research problems**	**CO1**
Part 2	**Identify a research question**	**CO2, CO3**
Part 3	**Literature survey**	**CO4**/CO6
Part 4	**Report writing**	**CO5**/CO6
Part 5	**Presentation**	**CO6**
Mode of examination	Rubric assessment Monthly Presentation to be audited by supervisor Mid Term Presentation and End Term Presentation	

Weightage	CA	CE	ESE	
	25	25	50	
Text book/s*	10 Recent International Journal Articles of repute.			

Course Articulation Matrix

Cos	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3
CO1	3	3	2	1	2	2	3	2	2	2	1	2	1	2
CO2	2	3	3	3	1	1	3	2	2	2	2	2	2	1
CO3	3	3	2	1	1	2	3	2	2	1	1	1	1	2
CO4	3	2	2	2	1	1	3	2	2	2	1	2	1	1
CO5	3	3	1	1	1	2	3	2	2	2	1	2	1	2
CO6	3	3	2	1	1	2	3	2	2	1	2	1	2	2

1-Slight (Low)   **2-Moderate (Medium)**   **3-Substantial (High)**

Research Project

School: SSBSR	**Batch: 2023-2027**	
Programme: B. Sc.	**Current Academic Year: 2026-27**	
Branch: Environmental Sciences	**Semester VIII**	
1	Course Code	BEN453
2	Course Title	Project
3	Credits	9
4	Contact Hours(L-T-P)	(0-0-18)
	Course Status	Compulsory
5	Course Objective	• Develop knowledge of a specific area of specialization. • Develop research skills especially in project writing and oral presentation.
6	Course Outcomes	**CO 1:** Reframe a research topic under study **CO 2:** Describe the research gap **CO 3:** Defend the best method to solve the problem **CO 4:** Categories and corelate the observation **CO 5:** Analyze observations and tabulate major research findings. **CO 6:** Report research findings in written and verbal forms
7	Course Description	Reading in a field of special interest under the supervision of a faculty member. Intended for students interested in studying topics not offered in regularly available courses. Format and grading are determined by the supervising faculty member and the audit members then approved by the Head of Department.

8	Outline		CO Achievement
	Part 1	**Introduction to various research problems**	**CO1**
	Part 2	**Identify a research question**	**CO2, CO3**
	Part 3	**Literature survey**	**CO4**/CO6
	Part 4	**Report writing**	**CO5**/CO6
	Part 5	**Presentation**	**CO6**
	Mode of examination	16. Rubric assessment 17. Monthly Presentation to be audited by supervisor 18. Mid Term Presentation and End Term Presentation	

Weightage	CA	CE	ESE	
	25	25	50	
Text book/s*	10 Recent International Journal Articles of repute.			

Course Articulation Matrix

Cos	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3
CO1	3	3	2	1	2	2	3	2	2	2	1	2	1	2
CO2	2	3	3	3	1	1	3	2	2	2	2	2	2	1
CO3	3	3	2	1	1	2	3	2	2	1	1	1	1	2
CO4	3	2	2	2	1	1	3	2	2	2	1	2	1	1
CO5	3	3	1	1	1	2	3	2	2	2	1	2	1	2
CO6	3	3	2	1	1	2	3	2	2	1	2	1	2	2

1-Slight (Low)   **2-Moderate (Medium)**   **3-Substantial (High)**